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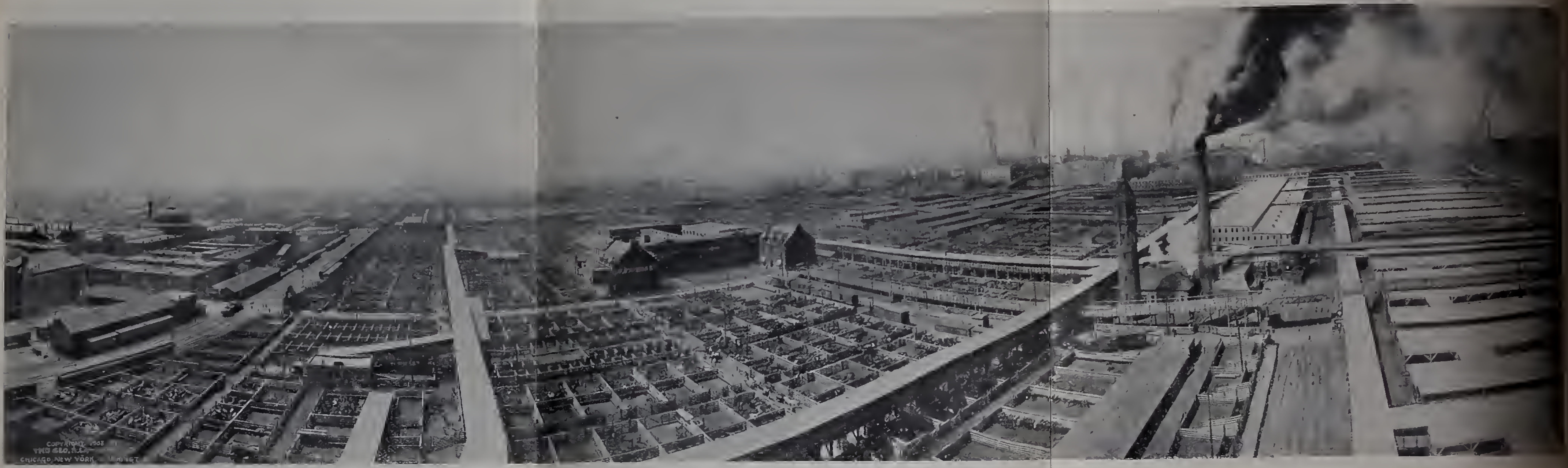
THE MEAT INDUSTRY
AND
MEAT INSPECTION



PANORAMIC VIEW OF THE STOCK-YARDS OF CHICAGO

This picture, which was taken from a balloon, gives an excellent idea of the immense capacity of the Chicago stock-yards— the largest live-stock markets in the world.

THE MEAT INDUSTRY
AND
MEAT INSPECTION

A COMPREHENSIVE ACCOUNT OF THE PRINCIPAL
ANIMALS AND FISH, INCLUDING CATTLE, SHEEP,
PIGS, POULTRY AND GAME, SUPPLIED TO THE
BRITISH MEAT MARKET, TOGETHER WITH
A DESCRIPTION OF THE VARIOUS INDUSTRIAL PROCESSES CONNECTED
THEREWITH AND THE SCIENTIFIC
INSPECTION OF MEAT

BY

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DOUGLAS' ENCYCLOPÆDIA FOR THE MEAT, BACON,
AND FOOD TRADES

THIRTY-FIVE COLOURED PLATES
ONE THOUSAND ILLUSTRATIONS

VOLUME II

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SHEET V. INTERNAL PARTS OF BODY

1. Cerebrum.
2. Cerebellum.
3. Pons.
4. Medulla.
5. Spinal marrow.
6. Section of vertebræ.
7. Ligamentum nuchæ.
8. Turbinated bones.
9. Pharynx.
10. Larynx.
11. Trachea.
12. Thyroid.
13. Bronchi.
14. Left lung.
15. Right lung.
16. Chest wall.
17. Diaphragm.
18. ,,
19. Left ventricle.
20. Right ventricle.
21. Pulmonary artery.
22. Aorta.
23. Right auricle.
24. Interior right ventricle.
25. Left auricle, interior.
26. Left ventricle, interior.
27. Chords of valves.
31. Cavity of mouth.
32. Tongue.
33. Hard palate.
34. Pharynx.
35. Gullet.
36. First stomach.
37. Upper part of 36.
38. Lower part of 36.
39. Pillars of stomach.
40. Papillæ.
41. Opening of gullet.
42. Paunch.
43. ,,
44. ,,
45. Spleen, milt.
46. Opening to second stomach.
47. Second, or reticulum.
48. Reticulum, interior.
49. Third stomach, omasum.
50. Leaves of 49.
51. Fourth stomach; abomasum.
52. Folds of 51.
53. Pyloric opening.
54. Duodenum.
55. Mesentery.
56. Jejunum.
57. Ileum.
58. Cæcum.
59. ,,
60. Colon.
61. Rectum.
62. Anus.
63. Liver.
64–67. Lobes of liver.
68. Gall bladder.
69. Bile ducts.
70. ,, ,,
71. ,, ,,
72. Entrance of vena cava.
73. Mouth of portal vein.
74. Ligament of liver.
75. Left kidney.
76. Section of 75.
77. Right kidney.
78. Ureter.
79. Bladder.
80. Neck of bladder.
81. Vent.
82–88. Male reproductive organs.

SHEET IV. MUSCULAR SYSTEM

1. Elevator of lips and nostrils.
2. Zygomatica.
3. Elevator of upper lip.
4. Nose muscle.
5. Lachrymal.
6. Depressor of under lip.
7. Masseter.
8. Sterno-maxillary.
9. Tendon of 8.
10. Orbit.
11. Eyelid.
12. Ear abductor, superior.
13. Middle abductor, ear.
14. Inferior abductor, ear.
15. Abductor, ear.
16. ,, ,,
17. Head and neck muscles.
18. ,, ,,
19. ,, ,,
20. ,, ,,
21. Pectorals.
22. ,,
23. ,,
24. Elevator of shoulder.
25. ,, ,,
26. Trapezius.
27. Brachial extensor.
28. ,, ,,
29. ,, ,,
30. Head of triceps.
31. ,, ,,
32. Scapular ulnaris.
33. Latissimus dorsi.
34. External oblique of abdomen.
35. Serratus magnus.
36. Rectus.
37. Great metacarpal extensor.
38. Common digit extensor.
39. Extensor of external digit.
40. External flexor of metacarpus.
41. Flexor of foot.
42. Oblique metacarpal extensor.

43–51. Tendons.

52. Gluteal.
53. ,,
54. Tensor vaginæ femoris.
55. Rectus femoris.
56. Biceps femoris.
57. Biceps (posterior part).
58. Semitendinosus.
59. Gluteus.
60. Curvator of tail.
61. Foot flexors.
62. ,, ,,
63. Abductor.
64. Peroneus.
65. Soleus.
66. Common extensor.
67. Abductor tendon.
68. Extensors.
69. ,,
70. Tail.

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57. Ileum.
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59. ,,
60. Colon.
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62. Anus.
63. Liver.
64–67. Lobes of liver.
68. Gall bladder.
69. Bile ducts.
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71. ,, ,,
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73. Mouth of portal vein.
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76. Section of 75.
77. Right kidney.
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81. Vent.
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62. ,, ,,
63. Abductor.
64. Peroneus.
65. Soleus.
66. Common extensor.
67. Abductor tendon.
68. Extensors.
69. ,,
70. Tail.

SHEET III. CIRCULATION

H. Heart.
L. Liver.
L. Trachea.
M. Stomach.
Mz. Spleen.
S. Œsophagus.
L.V. Left fore limb.
R.V. Right fore limb.
L.H. Left hind limb.
R.H. Right hind limb.

Arteries

1. Aorta.
2. Left coronary.
3. Anterior aorta.
4. Posterior aorta.
5. Left innominate.
6. Right innominate.
7. Left carotid.
8. Right carotid.
9. Œsophageal branches.
10. ,, ,,
11. Parotid.
12. Thyroid.
13. Pharyngeal.
14. Occipital.
15. Exterior maxillary.
16. Interior maxillary.
17. Lingual.
18. Facial.
19. Coronary, upper lip.
20. Coronary, lower lip.
21. Temporal.
22. Labial.
23. Upper labial.
24. Lower eyelid.
25. Anterior intercostal.
26. Oblique cervical.
27. Deep cervical.
28. Vertebral.
29. Interior pectoral.
30. Shoulder artery, not seen.
31. Exterior pectoral.
32. Axillary, not seen.
33. Radial.
34. Metacarpal, large.
35. Metacarpal, small.
36–40. Arteries to lower part of limb.
41. Œsophageal.
42. Bronchial.
43. Intercostals.
44. Diaphragmatic.
45. Cœliac axis.
46. Mesenteric.
47. Renal.
48. Spermatic.
49. Posterior mesenteric.
50. Lumbar.
51. Thigh arteries.
52. Pelvic.
53. Middle sacral.
54. Abdominal.
55. Skin.
56. Abdominal skin.
57. Posterior circumflex.
58. Obturator, branch.
59. Posterior tibial.
61. ,, ,,
60. Anterior tibial.
62. ,, ,,
63. Metatarsal.
64. Tarsal.
65. Plantar.
66. Hypogastric.
67. Ilio-lumbar.
68. Caudal.
69. Muscular.
70. ,,
71. Obturator.
72. Interior pudic.
73. Pulmonary.

Veins

74. Anterior vena cava.
75. Jugular.
76. Veins to head.
77. Posterior vena cava.
78. Portal veins.
79. ,, ,,
80. Portal vein.

SHEET II. SKELETON

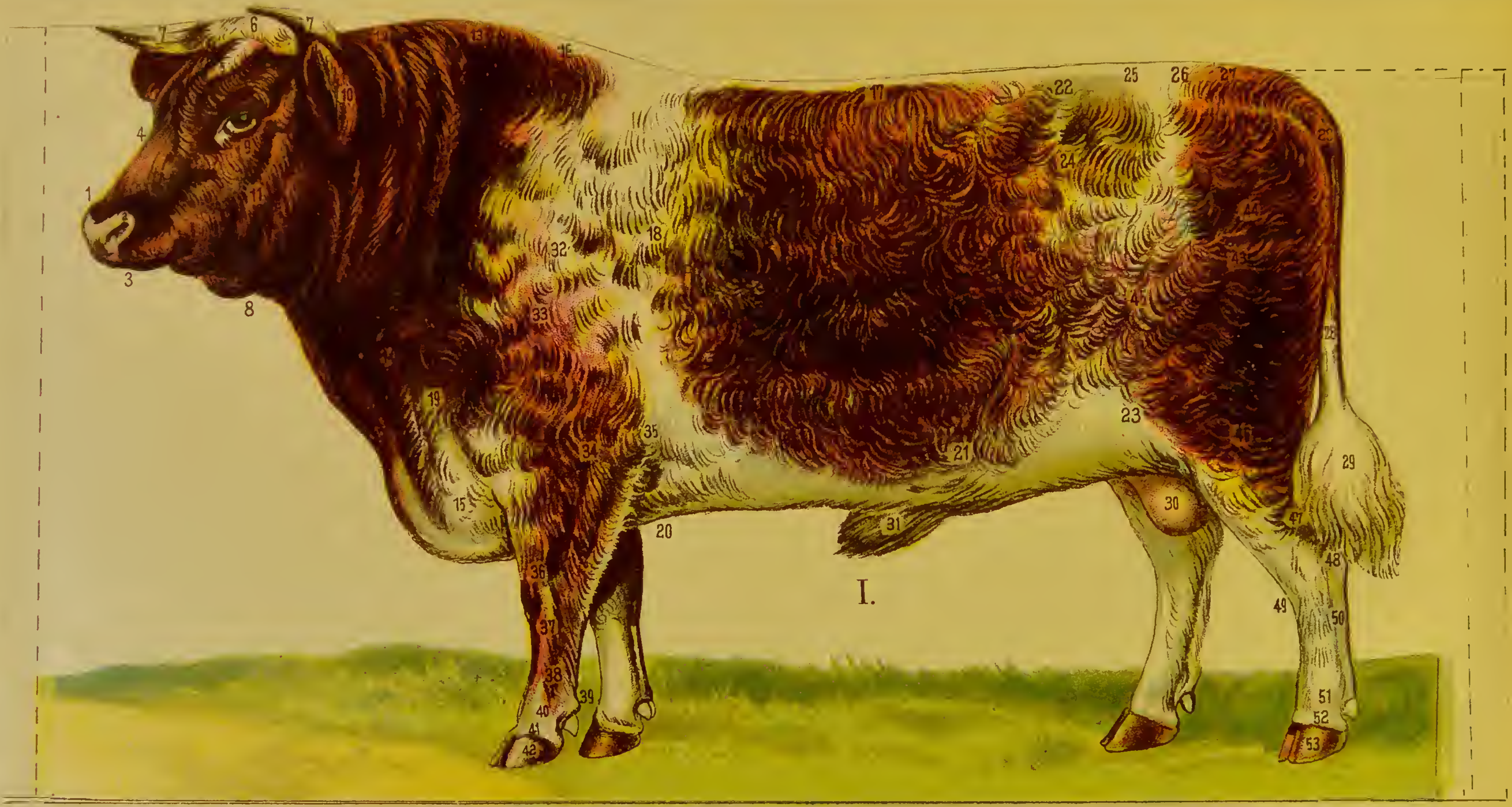
1. Upper jaw.
2. Lower jaw.
3. Occipital.
4. Frontal.
5. Horn core.
6. Frontal.
7. Lachrymal.
8. Molar.
9. Zygomatic.
10. Nasal.
11. Great maxillary.
12. Upper molars.
13. Great maxillary.
14. Temporal.
15. Orbit.
16. Lower molars.
17. Incisors.
18. Atlas.
19. Axis.
20. ,,
21. ,, } Cervical vertebræ.
22. ,,
23. ,,
24. ,,
25–37. Thirteen dorsal vertebræ.
38. Sternum.
39–44. Six lumbar vertebræ.
45. Sacrum.
46–65. Twenty coccygeal vertebræ.
66–69. Pelvis.
68. Os pubis.
70. Scapula.
71. Point of shoulder.
72. Upper arm bone.
73. Elbow, ulna.
74. Forearm, radius.
75. Elbow-joint.
76. Fore knee-joint, including 77–84.
77. Unciform.
78. Polygonal.
79. Lunar.
80. Scaphoid.
81. Semilunar.
82. Magnum.
83. Metacarpal.
84. Rudimentary sphenoid.
85. Sesamoid.
86. Pastern.
87. Coronet.
88. Hoof.
89. Navicular.
90. Femur.
91. Tibia.
92. Patella.
93. Stifle joint.
94. Hock.
95. Os calcis, heel.
96. Astragalus.
97. Scapho-cuboid.
98. Cuneiform.
99. ,,

EXPLANATION OF MODEL OF OX

This model is intended to display the general and detailed anatomical structure of any male bovine animal, of whatever type. The special beef animals and their points are dealt with in the volume itself.

SHEET I. EXTERNAL DIVISIONS OF BODY

1. Nostrils.
2. ,,
3. Mouth.
4. Nose.
5. Forehead.
6. Horns.
7. ,,
8. Throat.
9. Eye.
10. Ear.
11. Neck.
12. Nape of neck.
13. ,, ,,
14. Dewlap.
15. ,,
16. Withers.
17. Back.
18. Chest wall.
19. Shoulder.
20. Breast.
21. Belly.
22. Loin.
23. Flank.
24. Haunch.
25. Croup.
26. ,,
27. Rump.
28. Root of tail.
29. Tuft.
30. Scrotum.
31. Penis.
32. Shoulder region.
33. ,, ,,
34. Elbow.
35. ,,
36. Forearm.
37. Knee.
38. Shin.
39. Fetlock.
40. Pastern.
41. Coronet.
42. Hoof.
43. Upper thigh region.
44. Hip.
45. Groin.
46. Leg.
47. Lower leg.
48. Hock.
49. Shin.
50. Fetlock.
51. Pastern.
52. Coronet.
53. Hoof.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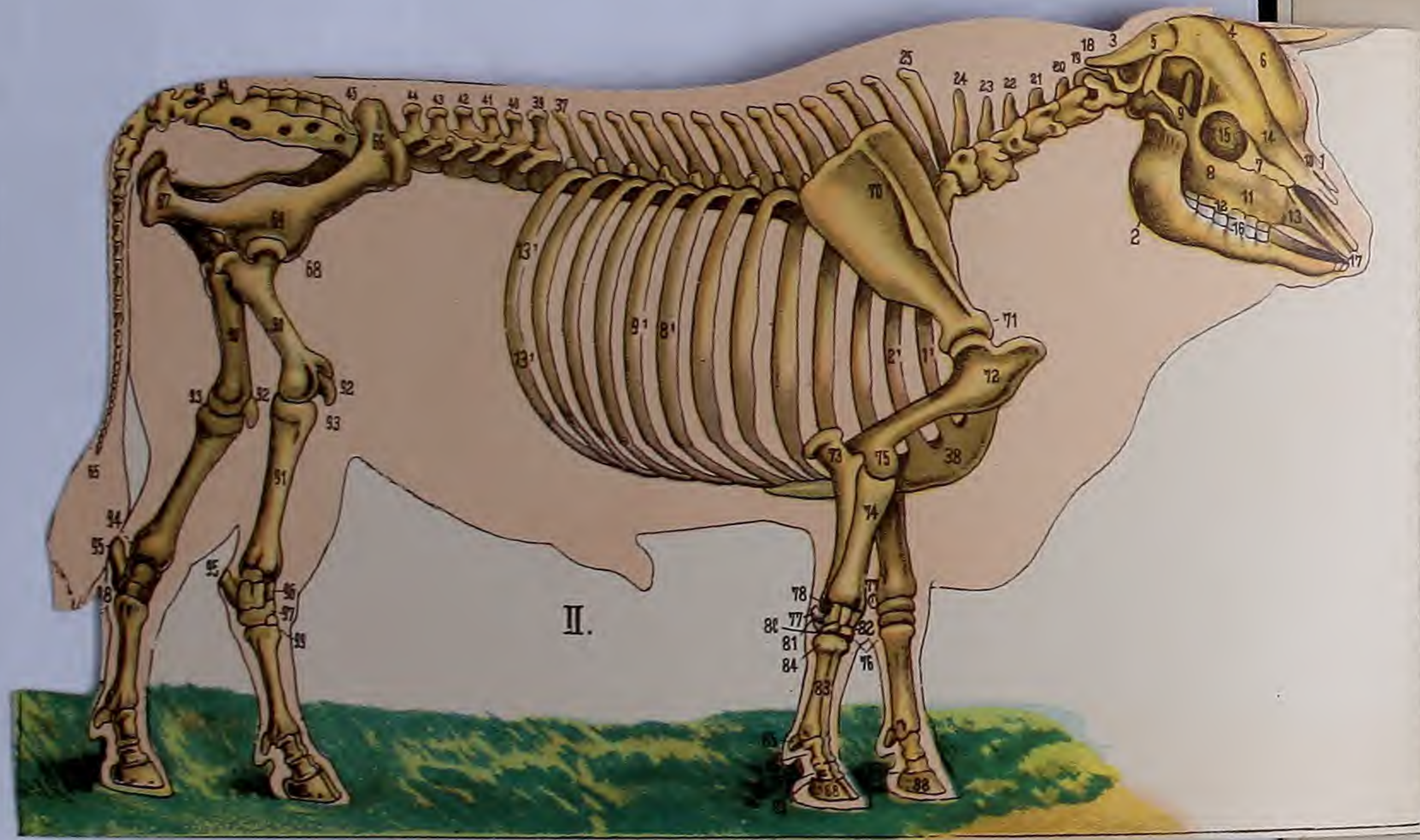
I.



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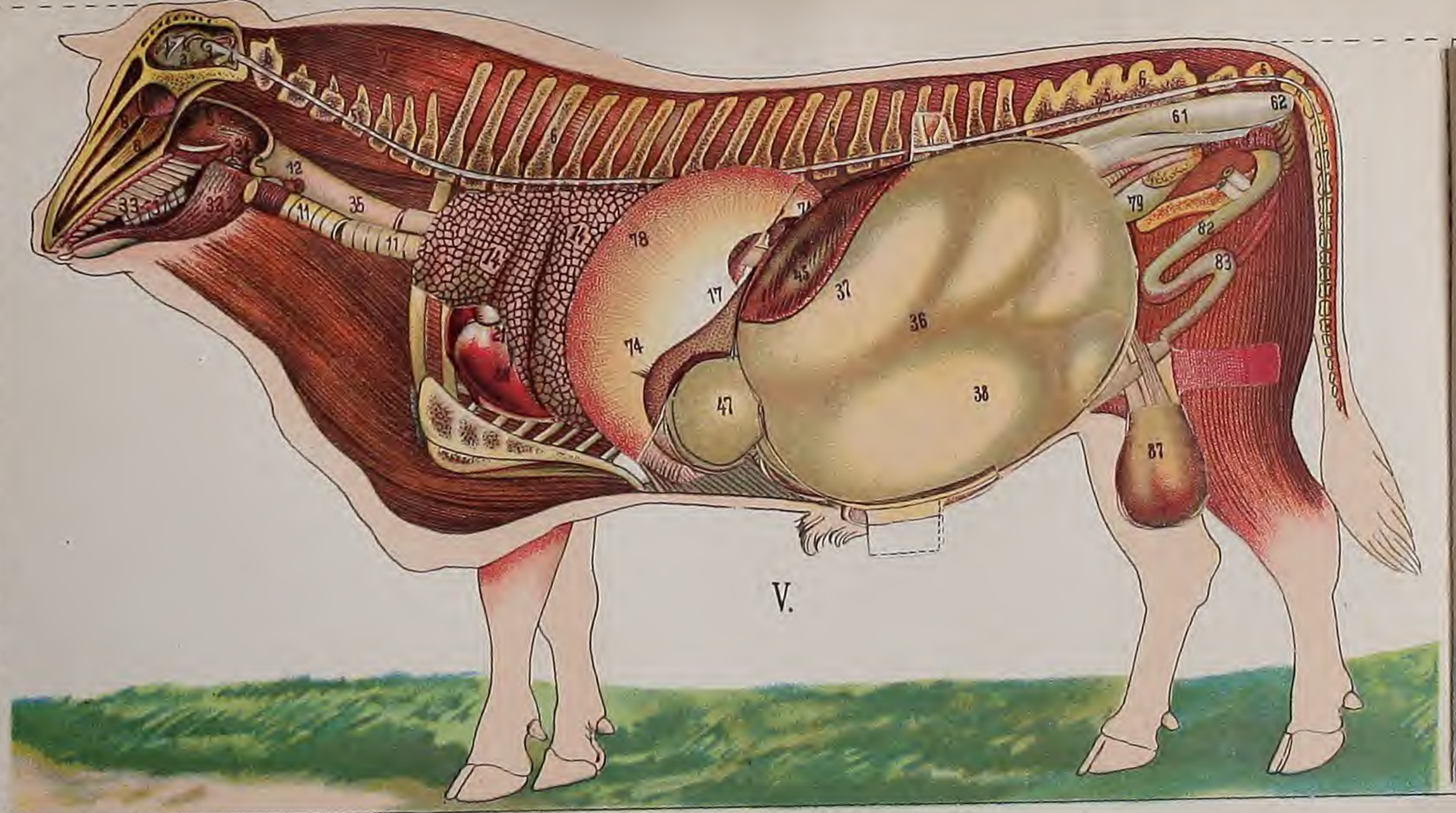

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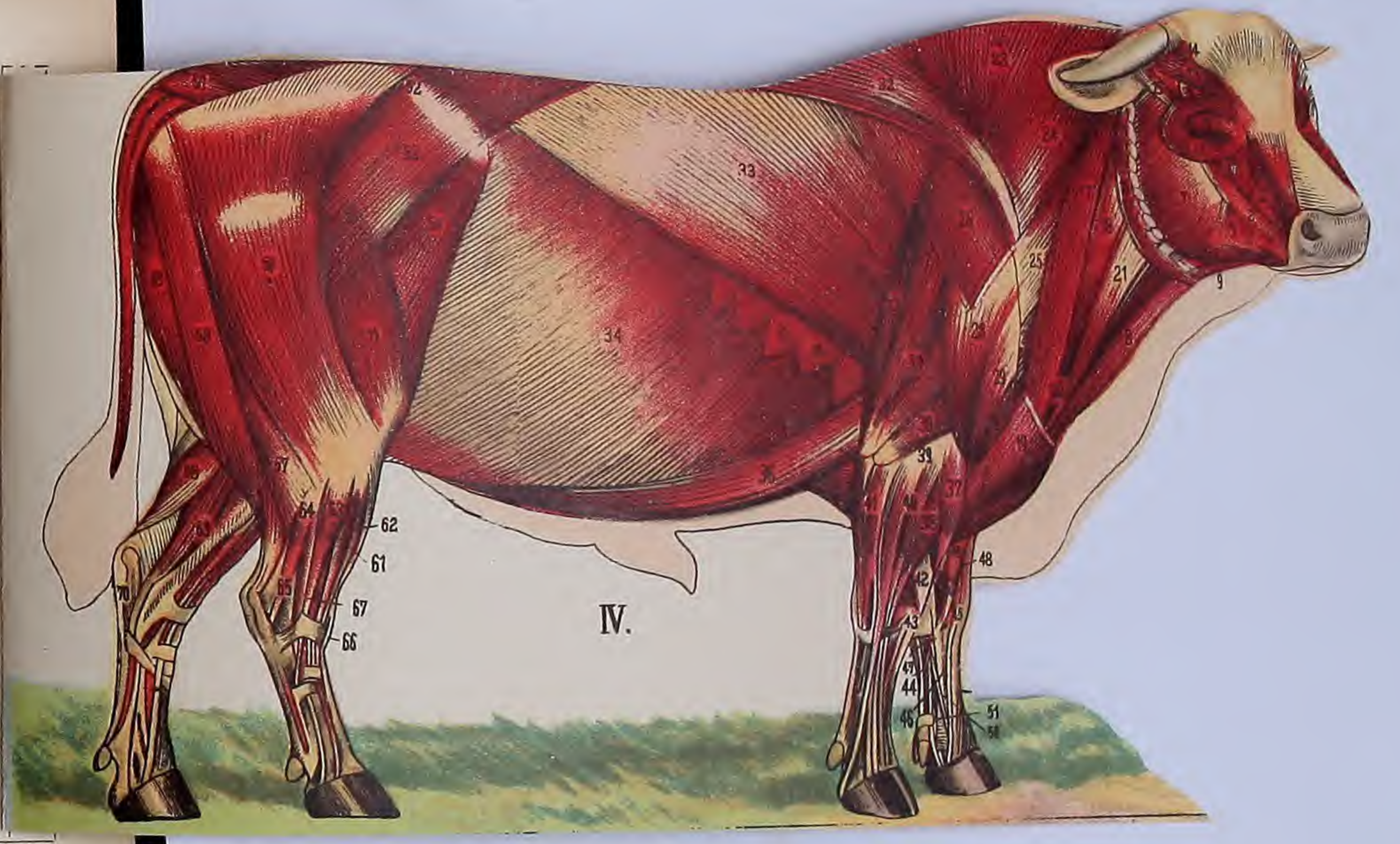

IV.

CHAPTER I

INTRODUCTION: GENERAL AND HISTORICAL

In approaching the study of the Meat Industry, it will be readily admitted that the subject is one of great importance. It may indeed be stated that the food-supply of which meat in its various forms constitutes so large a part, is the most important of all studies in the department of human economy. Curiously enough, however, the subject has not attracted such attention as its importance would warrant, and while science has made gigantic strides in other directions, it has not yet been generally applied in a systematic way to the study of the meat-supply. Of meat in its dietetic aspect we have considerable information, but of the production and handling of flesh-food in anything approaching a scientific way we have very little systematised knowledge.

Beginnings of the Meat Industry. The meat industry has sprung into existence in all countries in the most casual manner, and, although from ancient times express laws were enacted clearly defining what animals and portions of animals were suitable for food, these laws mostly applied to the Jewish people and were not followed generally. Perhaps the fact that some of the laws referred to were of an empirical and, so far as we can see, quite unreasoning character, may have had something to do with it, but, in any case, we do not find that the Jewish laws commended themselves to other nations. We will return to this matter in its own place, but here we may refer for a moment to the laws prohibiting the use of blood. We find that " the prohibition was mainly based on the ground that the blood was the seat of the Soul. It was, therefore, too sacred for ordinary use." * Such a law would only have a religious significance, and consequently would not be acceptable to those who did not agree with this particular religious belief.

Whether that is so or not, however, is not very material to us. What we find is that, through many centuries and in all countries, no particular education was considered necessary to those who handled meat, and it is only at the present day that we are beginning to appreciate that if, on the one hand, we have elaborated a system of dietetics based upon the chemical constituents of food, we have not, on the other hand, any system of controlling food in the shape of meat-products. It is true that we have a number of Food and Drugs Acts † which aim at protecting consumers of food against recognisable adulteration, but there is no place in our educational system wherein the meat trade, in any of its ever increasing developments, forms the subject of systematic instruction.

---

* *Enclo. Biblica.*

† Food and Drugs Acts, 1875, 1899.

The Nations and Their Food. When it is considered how many substances can be produced from a bullock, this appears remarkable, and would seem to indicate that there is a necessity for some means of disseminating knowledge to those who handle meat and its products, which would enable them, on the one hand, to conform to the Food Laws and, on the other, would permit of their appreciating the dietetic value of the foods which they handle. They would also be fortified with such knowledge as would permit of their understanding the conduct of the lower organisms, so that the possibilities of poisoning by diseased meat would be well-nigh impossible.

It would be idle to contend, however, that notwithstanding this absence of technical knowledge to which we are now awakening, the nations have not found out what foods suit themselves. We find that in every country food varies, and by a kind of instinct, has been devised so as to meet, in the main, the demands of the consumers. "Feed me with food convenient for me" * is the expression of a desire common to all and which has, from its ancient origin to the present day, influenced the food-supply in various countries.

The food consumed by various nations differs widely in character, and what would be repulsive to one nation is habitual with another. Thus the Esquimaux form their winter store of food under their huts and draw upon it according to need. The food consists of reindeer, whale, walrus, seal, swans, ducks, &c., but none fresh. It is frozen altogether in a compact mass, and gradually becomes a solid mixture with gelatinous snow between, and containing fish and animal oils ! † Such a mixture repels us, but in a crude way illustrates how the forces of nature in the shape of the Arctic climate are made use of to accomplish what we arrive at by the use of modern mechanical refrigeration.

Some of the tribes in Central Africa find their sustenance in putrid flesh ; some indeed in human flesh. The "Arabs often eat raw sheep's liver or kidney seasoned only with salt." ‡ This may strike the ear as being offensive, but in what particular degree does it vary from the habit we have in our own country of consuming putrefying game ? We like its gamey flavour—that is all ; and we are oblivious to the fact that it is produced at the expense of the flesh by the organisms of putrefaction.

How Tastes Differ. There are many curiosities of food, and different nations utilise so many different articles which do not appeal to others that the list of peculiarities is too long to refer to here in detail, but a few instances may not be uninteresting. Thus, the Chinaman looks upon the heads of various animals and birds as being dainties, and the tongues of fowls and ducks are esteemed a great luxury. A certain bird's-nest § also makes his most expensive soup. Russian "ox" tongues are commodities which are well known in this country. Does it detract from their value that they are sometimes derived from horses ?

---

[*] Proverbs, xxx. 8.

[†] Sir E. Belcher quoted by Simmonds in "The Animal Food Resources of Different Nations," 1885, p. 8.

[‡] Simmonds.

[§] *Hirundo Esculenta.*

In Holland, mutton is despised as a dish, whereas in France the *présalé* mutton is esteemed, because of its being grown on the pastures near the salt sea. Goat's flesh is rarely eaten with us, but it is common enough in some countries. To the Arab, the flesh of the kid is said to be tender and delicate, especially when boiled in milk.* Queen Elizabeth and the well-to-do of her time breakfasted on meat, ale and bread; but that hardy food has been displaced by something of a totally different character, and the fact that we have become less of a fighting nation than formerly may have something to say to this. The strong and intellectual nations of the earth are meat-eaters, and wherever animal food is displaced by vegetable diet there you will find intellectual and physical decay.

Man is essentially omnivorous, and to gratify his appetite lays under contribution the air, the earth and the sea, and, at least amongst the progressive nations of the earth, manages to adjust the balance of food in such a way as to satisfy the demands of nature and make good the daily waste which takes place. It is indeed stated by Gautier that the food balance-sheet of an average population pretty nearly squares and agrees with the theoretical teaching of the laboratory.† Thus, when the Esquimaux drinks his train oil, the Tartar his koumiss prepared from mare's milk, and the Hindoo or Japanese takes his rice and water, he unconsciously obeys a law of nature which requires that the food consumed must be in direct relationship to the energy expended.

Britain's Dependence on Imports. The food of the British nation is a tremendous problem, and one may only appreciate its significance by trying to conceive for a moment what would be the result if the external sources of supply were suddenly stopped. We live largely on imported food-stuffs, and more especially is this so with regard to meat. It has been computed ‡ that the consumption of meat of all kinds in the United Kingdom amounts to 121.77 lb. per head of the population, and of this figure 67.52 lb. are home grown and 54.25 lb. are imported.

A later computation gives the following figures :

TABLE § SHOWING THE CONSUMPTION OF MEAT PER HEAD OF THE POPULATION IN THE UNITED KINGDOM

Average.	Beef.			Mutton.			Pig-meat.			All meat.		
	Home.	Foreign.	Total.	Home.	Foreign.	Total.	Home.	Foreign.	Total.	Home.	Foreign.	Total.
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1890–1 to 1894–5 . .	39	17	56	19	6	25	16	15	31	74	38	112
1895–6 ,, 1899–1900 .	35	20	55	16	11	27	17	21	38	68	52	120
1900–1 ,, 1904–5 . .	36	22	58	16	11	27	15	21	36	67	54	121
1905–6 ,, 1907–8 . .	36	24	60	15	11	26	13	20	33	64	55	119

(The figures are based upon the Registrar-General's returns of population.)

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* Van Lennep.

† Gautier, " Diet and Dietetics."

‡ Rew, " Production and Consumption of Meat and Milk," 1904.

§ " The Meat Supply of the United Kingdom," by R. H. Hooker, M.A., *Journal of the Royal Statistical Society*, 1909.

We imported during 1909 meat of all kinds (excepting poultry and game) to the value of £41,016,388,* and this huge sum was spent on buying from other nations the common products of our own agriculture—mostly beef, pork and mutton. The manipulation of our sources of supply, their capture by speculators, or their limitation by war, would therefore mean famine, with all its attendant horrors, to a great part of the nation. The production of flesh-food to meet our own needs is thus a subject upon which we want definite instruction. For it cannot be said that the "Roast Beef of Old England" has increased in quantity alongside of the meat imports of foreign nations. The comparison is entirely the other way, and the rate of increase is greater in imported meats than in the home supply.

The Past and the Present Compared. It may be said in passing that there never was any justification for the phrase "the Roast Beef of Old England": meaning, as it does, that our forefathers had better supplies of meat than we have to-day. The facts show that the people in olden times *rarely had meat at all,* and that the rich, while they had plenty of it, were compelled to slaughter their cattle in October, owing to the absence of winter feeding, and salt them down to serve as the meat-supply until the spring.† As a matter of fact, we eat better beef to-day than ever before in the history of the nation.

The largest cattle-market in the world is at Chicago, and (*see* Frontispiece) it is in almost daily touch with the largest meat markets in the world at Smithfield, London; and that fact is one which indicates the trend of modern trade in meat products, towards huge monopolies. It would be a great misfortune, however, if such monopoly ever came to pass: it would not only be the end of all private enterprise, but would mean the utter destruction of home agriculture as the principal source of our food-supply.

Side-lines of a Great Industry. Concurrently with the betterment in the quality of the meat, and the increase in the quantity, there has arisen quite a new and ever extending industry in the manufacture of various products from beef, pork, veal and mutton, and the technical knowledge involved in this branch of the meat trade is very extensive. Sausages of many kinds are made in large factories and also in shops. Pickled meats also form a large part of the meat trade. Potted meats, brawns and similar preparations have risen high in popular estimation. All these products require skill in their preparation, and as we have said, there is nowhere in this country where systematic instruction in these matters may be obtained.

The detection of disease and the utilisation of meat which may be questionable, are subjects of the highest importance to the health of the community. But again, no effort is made to instruct these most interested in knowing, viz., the meat-purveyors.

In Germany there is a system of utilising meat from a partially diseased animal. The meat is cooked in the abattoirs under the supervision of the authorities, and is thus made available to the community. Why should such an enlightened system not prevail everywhere? It is a matter of knowledge and education.

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* Annual Statement of Trade, 1909.

† Hume, "History of England," chap. xxvi.

We have had some regrettable epidemics of poisoning, due to the presence of ptomaines in meat, and the fact that these outbreaks are frequent, illustrates the point that it never seems to occur to any one in authority that the most effective way to prevent them is by educating the meat-purveyor in the technicalities of his business, so that he would recognise the danger of using diseased materials and the necessity of providing sanitary and hygienic premises.

HISTORICAL

The origin of the Meat Industry is somewhat obscure. Historical references are of a very scanty character, and of actual written history there is none. We must, therefore, try to build up a connected narrative as well as we can, from such references as we can find scattered throughout the literature of the different ages.

The food of primitive man seems to have consisted largely of fruits and grains, and the transition period from the time

> "When the world was young
> Ere yet the barbarous thirst of blood had seized
> The human breast" *

is not one of which we know very much. We are indeed indebted to archæologists for much information which they have gleaned from the study of the remains of the past. All their knowledge indicates that man has passed through four different stages in the existence of the world. First, the savage state, where the struggle for existence was merely a contest with the lower animals for food. The second state was that of nomadic existence, and the developments of ownership of flocks and herds. The third state was that of the early agriculturists who tilled the soil and multiplied its resources. The fourth state is the greatest of all, and is associated with the development of industry.†

In every one of these phases the motive which predominates is the desire for food, although it may appear in very different guises in the various ages.

Laws governing the Slaughtering of Animals. In historical times we find that the ancient Athenians, and other nations, prohibited the slaughter of the ploughing or the labouring ox either for sacrifice or food.‡

Indeed, it is noticeable that, co-incident with the dawn of civilisation, strict laws were enacted in connection with the slaughter of animals. The Buddhists considered it a sinful thing to kill any animal for food, and Moses, Manu and Mahomet, laid down various laws prohibiting the use of certain animals as being unclean.

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* Armstrong, "The Art of Preserving Health."

† Archæology and Anthropology," *Encyclo. Brit.*

‡ Potter's "Grecian Antiquities," quoted in *The Experienced Butcher*, 1876.

The most complete system of control was that conveyed by Moses to the Hebrews. They were free to make use of whatever vegetable products they desired, but were forbidden the use of certain animals. Animals were classified as " clean " or " unclean," and an apparently empirical distinction was made between these : at any rate, the reasons for the classification are obscure.

The clean animals were the ox, the sheep, the goat, the hart, gazelle and roebuck, wild goat, pygarg, antelope and chamois. The unclean were the camel, hare, rock-badger and swine. Generally, " whatever divideth the hoof and cheweth the cud shall be clean." The prohibition of the use of blood as being unclean is easier to understand, as in early scriptural times the blood was regarded amongst many nations as the seat of the spirit of life, and was thus sacred. Incidentally, however, the prohibition was unquestionably a hygienic necessity, as the use of blood indiscriminately would have meant the dissemination of much disease. The other prohibitions of the Mosaic laws are interesting as displaying a keen instinctive appreciation of hygiene, although the thoughts are not expressed in technical language. The intestinal fat of the ox, sheep and goat was prohibited, as was also the flesh of animals that had died a natural death, or of such as were torn to death by wild beasts, or strangled. In connection with the latter, we see the origin of the custom prevalent amongst the Jews at the present day of using a very sharp knife with which to sever the main arteries of the neck quickly ; the use of a harvest sickle, saw, &c., being prohibited " because they strangle." *

Animals used in Sacrifice. The principal use to which animals were put in ancient times was that of sacrifice, or offering their lives as an atonement for sin. Such occasions were sacred, and in many instances the priest slaughtered the animal, and for this service received certain choice portions as his perquisite. Many other occasions also lent themselves to this rite, and even at the present day we see the practice in existence amongst the Arabs, who still make sacrifices of living animals on joyous occasions, or to mark some signal advantage they may have gained. A writer on this subject says : " The rites of sacrifice amongst the Arabs are of primitive simplicity. The owner ordinarily slaughters his own victim. The blood is poured upon the ground, smeared upon the sacred stone, upon the tent-ropes, the door-posts of houses, or upon persons or animals. The flesh makes a feast for the owner, his family, tribesmen and guests."†

We cannot pursue the history of this particular phase of the subject with any great detail here. Our object is to illustrate as far as possible how the meat industry sprang into existence, and we see that, so far, the use of the flesh of animals was associated with religious rites. The recognition of the meat industry had not commenced.

In fact, it was not till much later that any such recognition took place. Under the law of Moses, in the daily sacrifice of the tabernacle and the temple, the victim was sometimes slain by the priests and sometimes by the inferior ministers; and, at the feast of the passover, each head of a family was at once priest to kill the sacrifice and the butcher to slay for the food of the household.

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* *Encyclo. Biblica.*

† *Ibid.*

The Practice of Greeks and Romans. Among the ancient Greeks it was likewise the office of the priests to slay the victims for sacrifice, and of the head of the family or his sons to kill for food.* Such an office, however obligatory, apparently proved distastetul in the Roman Empire, and we find that it was finally abolished.

The Romans, until about A.D. 300, practised the slaughter of animals in the Forum under the eyes of the gods, still believing that their deaths were acceptable as an atonement for sin, but about that time a new era dawned, and slaughtering was placed upon a proper basis. They established what were termed "Macellæ," in which it became lawful to slaughter animals for food. The name is said to have been derived from that of a man called Romanius Macellus, who was a robber and whose house was demolished in order to make room for a market in Rome. There is, however, an air of mystery about the word, and it is not unlikely that it was derived from the Latin *maceria*, meaning an enclosed space.† These macellæ were utilised not only as markets for flesh, fish and provisions, but were also the first organised abattoirs.

There were three classes of butchers in Rome: the Suarii, who provided hogs' or pigs' flesh; the Buarii or Pecuarii, who provided beef and mutton; whilst a third class consisted of the Lanii or Camifices, who did the actual slaughtering. The members of the slaughtering class were usually slaves, and their occupation was held in such low esteem that they were not permitted to reside within the city boundaries. In course of time, however, the character of the actual slaughtermen altered, as it was found that the work was really a skilled occupation, and hence freemen were called upon to take it up, and the participation of the slaves was abolished.

In this way the industry emerged from obscure surroundings and became one of the established arts which contribute to the comfort of mankind. Unfortunately, as in the ancient history of the craft, so in the modern: there is a notable absence of historic records such as may be found in connection with other trades, and this is so marked that from the Roman period right up to the Middle Ages, there is an almost total absence of information. We are able to glean from the annals of husbandry that there was a certain distinct meat trade, but that it was not sufficiently organised to be looked upon as a skilled vocation.

In Mediæval Times. The values of animals used for food in mediæval times were extremely low as compared with the present day. A sheep could be bought for a shilling, an ox for ten shillings, and, according to the established weights as purchased by the navy in 1547, would weigh about 430 pounds : * It is, perhaps, for this reason that no records of the meat trade are available, as the amount of wealth to be obtained would not attract the more intelligent tradesmen : one thing seems to be certain, namely, that the business was viewed with great suspicion, and its members suffered many disabilities. We find, for example, that butchers were not allowed to serve on juries when sitting on the life of a subject, and it is also stated that the English law would not accept the evidence of a butcher. There were, perhaps, contributory causes to the general fact that the business was under a cloud until the organisation of the trade guilds, which not only established the position of the meat trade in many countries, but also procured recognition for industry and labour where they had been previously despised.

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* *The Experienced Butcher.*

† Smith, "Dictionary of Greek Antiquities."

THE BANNER OF THE FLESHERS' CORPORATION OF SELKIRK
This banner dates from great antiquity, its origin being unknown.
At one time it must have been the banner of the Guild Corporation.

The Early Trade Guilds. The trade guilds were associations of men who followed the same vocations. They came into existence about the eighth century, and their principal object was mutual defence against the aggression of the wealthier classes. Hereditary owners of property governed in all the cities and passed such laws as suited themselves. Hence the institution of the trade guilds was in the nature of a revolution, and the movement spread all over Germany, France, Italy and the

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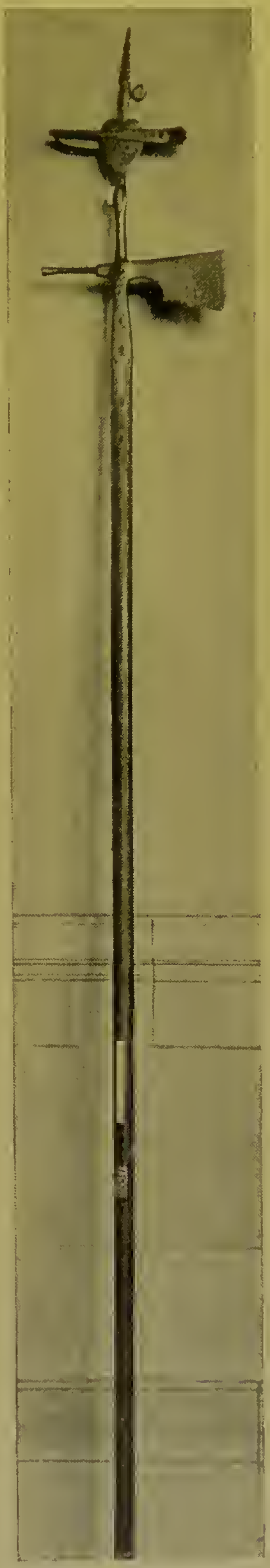
* Rogers, " History of Agriculture and Prices," vol. i. p. 67.

United Kingdom, resulting in much national progress. To understand exactly what they meant to the meat industry we must remember that the towns and cities had two classes of inhabitants, viz., the hereditary freemen or owners of property and officials, on the one hand; on the other were the bondmen from which class the craft guilds originated.* The guilds rebelled against the payment of feudal taxes, which were exacted from them by the hereditary superiors.

In so far as Scotland is concerned, the Flesher Guilds have had a long and interesting history, and documentary evidence is available showing that in Edinburgh, Glasgow, Dundee, Aberdeen and Selkirk, they stood high in the government of these cities.† We find that in Edinburgh the Fleshers' Corporation was one of the fourteen incorporations whose banner was known as "The Blue Blanket," and according to a history of that emblem, in which the "powers and prerogatives of the crafts thereof" are set forth, the Fleshers were incorporated before 1488. The coat-of-arms used by the Edinburgh Master Butchers' Association to-day is a reproduction of the old insignia as it appears in the book referred to.‡

Pioneers of Modern Town Councils. The conflicts between the merchants and the members of the craft guilds were frequent and very often bloody, and resulted, in the fourteenth century, in the recognition of the right of the craftsmen to elect the dignitaries and officers of the cities. They were in fact, throughout Europe, the pioneers of the modern town councils.

In Aberdeen the records of the city state that in 1399 four *appreciatores carnium* (meat inspectors) were appointed to examine the quality of the flesh sold in the town, and from that date onward regulations concerning the fleshers are from time to time recorded.§ It would appear that the magistrates, besides appointing the inspectors, also ordained what the prices of the meat should be and under what conditions it should be sold. Unfortunately for us, the earliest records for Aberdeen are not available, as the idea that posterity might like to know what they did in those days does not seem to have impressed itself upon our forefathers! Fragmentary notices, however, dating back to the seventeenth



Ancient Scottish Halberd belonging to the Fleshers' Corporation of Selkirk century, can still be read by the curious, as one or two examples will show:

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* "Brentano on Guilds," 1870.
† Bain, "Merchant and Craft Guilds," 1887.
‡ Alex. Pennecuick, "The History of the Blue Blanket," 1833.
§ Bain.

"6th March 1680—The said day the haill trade unanimously statutes and ordains that in all tyme hereafter whoever shall be deacon (of the Flesher's), that he shall have a forme for his seat in the dask in the old church belonging to the trade keep it for him till the third bell be rung in, and that the officer whosoever the same shall happen attend his deacon and boxmaster anent the keeping of the said seat and attending of him otherwayes conform to his oath under the failyie of twenty shillings Scots for each fault toties quoties." *

Again:

"25th April 1793—The said day the trade having taken under their consideration that it has been the practice for some time past for entrants to this trade to give what is called speaking pints to the masters and others of the trade, and at the passing of their essay to give an entertainment of meat and drink, of which the essay made a part of the whole members of the trade at a very considerable expense to the entrants, tending to no benefit to the trades funds, or any other purpose but an abuse of money, do therefore hereby statute and enact that in time cuming all speaking pints and entertainments such as have formerly been given by entrants to the members of the trade shall be abolished and set aside, and the entrants shall be at liberty to dispose of his essay after it is passed at pleasure, and be under no obligation to give any entertainment as formerly, with which practice the trade unanimously and heartily dispense in time cuming." †

These quaint references show how intimately the social life of the day was mixed up with the trade guilds.

The Guilds in Scotland. It is also interesting to notice that in connection with Aberdeen they had a Trades House there, gifted by a certain Dr. Guild to the various trades in 1633. But, unfortunately, the fleshers were omitted, and after much negotiation and expostulation, together with the payment of "400 merks good and usual money of this nation," the guild of fleshers was duly admitted to all the rights and privileges of the hospital.

In Glasgow there were fourteen crafts, as there were in Edinburgh; in Aberdeen and Stirling the number was only seven; in Dundee nine; in Perth eight; in each case the fleshers being one, and the rights and privileges were practically identical in each city. Primarily instituted in self-defence, these guilds developed into associations to encourage thrift, the making provision for old age and for poor and distressed brethren. In Scotland they earned the reputation of being conducted in a thrifty manner, and in such a way as to ensure that, should misfortune overtake the guild brothers, there would be insurance against want.

These old guilds have long since passed away, and their places have been taken by modern associations with different ideals, more in conformity with our national life. We may be permitted to say, however, in passing, that they not only served their day well, but in their example have left a heritage which modern associations would, in many respects, do well to follow.

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* Bain, p. 312.

† *Ibid.* p. 314.

The Trade in England. To make our historical references more complete, it will be necessary to turn our attention for a little to the records of the trade in England. It is the more necessary to do this as the final act of abolition of the guilds in the United Kingdom affected all alike.

Fleshers' Guilds in England were brought into existence in very much the same way as those in Scotland, and their constitutions were very much similar. Only those could be members who intended to practise the trade, and it was necessary for any one who wished to become a freeman of a guild to enter himself as an apprentice and serve from three to five years, and then be a journeyman for three more years, before he could be made a guild brother and a master butcher! The length of the apprenticeship was simply absurd, considering that then, no technical instruction, beyond the mere handling of the meat, was given or, for that matter, considered necessary. That view is happily passing away, and it is gradually being recognised that the man with technical knowledge is worth very much more than the mere rule-of-thumb individual, and, as a consequence, the necessity for technical instruction is becoming greater every day.

When Bull-baiting was Popular. The butchers of London have a long record, inasmuch as they were incorporated by James I. in 1606. They are described as "The Master Wardens and Commonalty of the Arts and Mystery of Butchers of the City of London," but there is even a further back reference than that, as we find that "The Butchers Company" were fined for setting up without royal licence in 1180! Throughout England, however, the records are very scanty. It is recorded that the butchers of Chester so far back as 1328 played in a piece called *The Temptation*. It is also recorded that bull-baiting formed one of the sources of amusement of the butcher.

One can hardly conceive of the utter depravity which such a "sport" really meant. Bull-baiting, however, was so associated with the trade that it had to be abolished by special Act of Parliament so late as 1835. Happily, since then an atmosphere of repugnance to the cruel treatment of animals has arisen, and is likely in these times to lead so far as to re-model our whole slaughterhouse system. There is no question that the slaughterman ought to be a properly skilled workman, and should also be made to use weapons of precision in his work.

It may not be out of place to suggest here that there should be a clear differentiation in the terms used in the meat industry. The terms met with in studying the literature of the subject are various, but it is at least apparent that it is incorrect to say that a man is a "butcher," meaning by that a slaughterman, when he is in reality a meat-purveyor. The word "flesher" is perhaps more expressive, as it conveys the idea of the selling of flesh. But even that is not nearly so appropriate as "meat-purveyor," which as a descriptive title is nearer the truth, in so far as nine-tenths of the members of the trade in the United Kingdom are concerned.

Modern Conditions. There are now no particular laws which govern the meat industry. Any one may set up a place of business whenever and wherever he pleases, and sell meat. That is because the trade has not yet been completely organised. In fact, it may be said that ever since the exclusive trading privileges which the guilds enjoyed were curtailed by Parliament in 1835, and abolished in 1846, very little progress has been made in the meat industry. In 1888 a Meat Trades' Federation * was founded and has grown to large dimensions ; so large, indeed, as to become a power in the country which is likely to be felt in the future. But, beyond defending the rights of its members in trade questions it has done nothing so far for the advancement of technical education in the meat industry. It is to this association, which now (1909) consists of 144 affiliated associations throughout the United Kingdom and nearly 20,000 members, that the meat trade looks for guidance in such a matter, and it rests with it to secure for the younger members of the trade the inestimable privileges which only knowledge can command.

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* *See* Vol. V.

CHAPTER II

LIVE-STOCK MARKETS AND FAIRS

BEFORE the Meat Industry possessed even the semblance of organisation, live-stock markets and fairs were in existence, and amongst the great nations of antiquity flocks and herds were looked upon as evidences of wealth. Even at the present day, amongst uncivilised races this same view prevails.

Fairs and markets were not, in ancient times, synonymous terms, a fair being a much more extended occasion than a market; thus, a fair might be carried on over a period of several days, whereas a market would be complete in one day.

In Biblical times it cannot be said that there were any distinct fairs held on account of flocks and herds, the nomadic condition of the peoples then lending itself to immediate barter as occasion arose, and it was not, perhaps, until the great expansion which took place in consequence of the enterprise of the Phœnicians and their very successful colonisation of many countries, that stated and fixed occasions for barter became so necessary. The Phœnicians carried their enterprise and exploration from the north of Africa to the Baltic, and even discovered that in the county of Cornwall there were rich stores of tin and other metals, and, as they grew in numbers and mingled with the native races of the countries into which they migrated, it became apparent to them that organised occasions for the buying and selling of goods, or the bartering of goods, became a prime necessity. In this way fairs arose, and as they grew in importance they became associated with religious festivals, the Church authorities being glad to encourage the development of industry, which collaterally meant increasing their own revenues. It is also said that, although such fairs * were held round about the churches, they were not regarded—at least until later times—as being in any way incongruous, and it is even said that the priests would take advantage of such opportunities to do some business on their own account, by advancing money at interest to either buyers or sellers. In the reign of Henry VI., however, during the first half of the fifteenth century, these customs were abolished, as being apt to recall the buying and selling of goods in the Temple.

Where the Great Fairs are Held. Even at the present day there are some great fairs held which have not given way to the facilities for the transport of goods which are now available. Notable amongst these great fairs is that of Nijni-Novgorod, in Russia, which lasts for some six weeks, being held in August and September of each year, and it is stated that the sales during that period might amount to between £10,000,000 and £12,000,000 sterling. At Usundji in Roumania, Debreczen in Hungary, Leipzig and Frankfort-on-the-Main in Germany, Champagne and Beaucaire in France, great fairs are held, and they are made the occasion for the buying and selling of all kinds of live-stock, as well as many other kinds of agricultural produce. So also in the United Kingdom there are still some notable fairs held every year, such as the Nottingham Goose Fair, the Fair of St. Bartholomew in London, the Glasgow Fair, the Hallow Fair in Edinburgh and the Falkirk Tryst. In Ireland the great fair is that of Donnybrook, near Dublin, but intermingled between all these there are lesser fairs which have purely local significance and which exist solely for the buying and selling of live-stock and agricultural produce.

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* Sir James Marwick's "Market Rites and Tolls."

The greatest of all the fairs in the United Kingdom was that of St. Bartholomew, which was instituted in the City of London in 1133 and proclaimed for the last time in 1855.* At the beginning it usually lasted some fourteen days, but prior to its being finally abolished it was curtailed to four days.

St. Bartholomew Fair was by far the most important that has ever existed in the United Kingdom, as not only was it the principal market for all kinds of cloth, dry goods and hardware, but it was also the principal cattle-market in the country, and the prices realised at St. Bartholomew's set the fashion elsewhere. Unfortunately, however, in common with all great fairs, St. Bartholomew's dwindled into an annual concourse of all kinds of second-rate amusements, and finally became such a rabble that it was deemed necessary to abolish it altogether. Most of the great fairs of which we have any record have always had the accompaniment of these cheap amusements, and it is possibly due to the fact that they tended to predominate that the serious buying and selling, more especially of agricultural produce, has slipped away from them.

Fairs Controlled by the Crown. It may be of interest to refer for a moment to the rights which existed in connection with fairs in the United Kingdom.

Their establishment belonged exclusively to the Crown, and they were therefore constituted by authority, and it is obvious that some special constitution of this sort was required, considering the privileges which they possessed. The Crown very often appointed some local nobleman or landed proprietor to collect tolls on all articles sold and on all live-stock which passed through the fairs, and some of these manorial rights exist even to the present day. In certain fairs and markets such tolls are levied for the benefit of a private individual whose only title to receive such emoluments consists in some such privilege having been granted to his ancestors by royal prerogative. In some of the ancient fairs also, a curious court described as the Court of Pie Powder (so-called from the French words *pied poudre*, which means dusty feet), and in which some jurisdiction obtained, concerning all acts which might take place to the prejudice of law and order. Such a court in later times became merged in the office of Clerk of Markets, and at the present day the judicial functions attaching to the position have been entirely abrogated.

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* Professor Morley's "Memoirs of Bartholomew Fair," 4th edition, 1892.

The importance of fairs has altogether been altered since the advent of quick means of transport, and it has also been found that it suits agricultural pursuits better when markets are specially established for the sale of specific live-stock. The custom, therefore, pretty generally now prevails of having separate cattle-markets for the sale of cattle and sheep-markets for the sale of sheep, and in many places the functions of the fair and market have been entirely superseded by private sales, or by weekly markets instituted by live-stock salesmen.

In Ireland the fair still exists in many parts, and this is due to the fact that some of the rural districts are remote from towns and have not the advantage of quick transport to distant markets. Hence, it suits the small farmer to bring his produce to a fair, where it is likely to fetch as good value at least as the other stock offered, provided always that the quality is the same. At the present day, however, the conditions are changing so rapidly that it would appear that, within a few years' time, the particular uses of the fair will disappear and all live-stock will be bought and sold by weight. In connection with the sale of pigs, such a transition is quietly taking place in Ireland at the present moment, where a number of the bacon merchants have set up live-weight scales at various places, and where they offer to take the pigs from the farmers by live weight and pay for them at once.

In the markets of the United Kingdom, under the Markets and Fairs Weighing of Cattle Acts (1887-91) it is made compulsory for all local authorities to "provide and maintain sufficient and proper buildings or places for weighing cattle brought for sale within the market or fair, and shall keep therein or near thereby the weighing-machine and weights for the purpose of weighing cattle, and shall appoint proper persons to have charge of such machines and weights and to afford the use of such machine and weights to the public for weighing cattle, as may from time to time be required."

Old and New Customs. The provision of such live-weight scales has undoubtedly been an enormous advantage both to the agriculturist and to the meat-purveyor. Previous to the passing of these Acts, buying and selling were largely a matter of guess-work, and even at the present day there are some considerable markets in which the custom obtains, and where farmers refuse to sell by live weight, or where buyers refuse to buy in the same way. Where such customs prevail, it will generally be found that the sellers and buyers are perfect judges of the weight which live animals will turn out, and they therefore prefer to take the risk of any loss rather than submit what they consider as their own skill and judgment to the mere mechanical process of the live-weight scales. That custom, however, like a good many more, will in a few years' time pass away also, and the business of buying and selling of all kinds of live-stock will then be reduced to an easy, understandable process, which will enable the seller to obtain fair weight for his live-stock and the buyer to get fair value also.

The Smithfield Club. In this connection nothing can be more significant than the inclusion in our various live-stock shows of a class for carcases, under what is termed the "block test." The Smithfield Club, which is by far the most important live-stock society in the United Kingdom, instituted this particular class in 1895,* and ever since that day increasing interest has been taken in the competitions. It will be remembered that the Smithfield Club exists primarily for the encouragement of the breeding of live-stock designed for the meat trades, and it seems a curious thing that it is only within comparatively recent years that this class should have been instituted and that its introduction should have been met with a good deal of opposition from cattle-breeders. The class, however, has come to stay, and the exhibition of the carcases of animals which have been previously judged alive has shown that the so-called "points" of certain breeds require readjusting (*see* chap. xi.).

In so far as the judging of the carcases is concerned, that is a matter which requires some consideration, and in connection with this particular show it may not be inappropriate to quote what the author has already written elsewhere on this subject.

"The live animals were previously judged, and in the tabulated statement published by the Club some discrepancies between the verdicts on the meat exhibits and these are plainly visible, which in its own way is another indication of the difficulty of judging any animal by external points. In so far as standardised points on the judging of the meat is concerned, there is no system yet devised.† That will no doubt come in time, and it will be better for all concerned when the judging is reduced to a method which will give each specific feature a value in figures. The methods at present in use are, roughly, as follow:

"**How Meat is Judged.** Meat is judged generally by the relative proportions of meat to bone, the best being that which has least bone to the greatest quantity of flesh. There are then certain specific points which are noted—first, the marbling of the loin meat due to the presence of the necessary amount of fat; secondly, the coarseness or otherwise of the carcase is judged by the breadth and wastage across the shoulder—the smaller this is the better; thirdly, the belly part of the ribs should be slight, as that part of the carcase is of small value. Lastly, the roast meat should be abundant, and running in a straight line to the loin fore-rib. The minor features do not at present enter much into the points taken notice of, but colour is duly noted, and if the fat does not present a creamy appearance, indicative of richness and texture, it is reckoned as being inferior. Kidney-fat is not at present regarded as being in any way a guide to quality.

"The carcases of sheep and lambs are divided transversely through the middle, and so as to expose the thickest portions of the 'eye' of the chops. Colour is the first feature regarded, and after that, thickness of lean and firmness of fat; loose fat or a 'rindy' skin on a sheep's carcase is indicative of improper care in rearing. The legs of mutton are required to be plump in character and forming an almost straight line from thigh to thigh. The V-shaped hind legs are of an inferior quality, and will, most likely, present other features of bad breeding.

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* "History of the Smithfield Club."

† This has now been done; *see* chap. xi.

"Pig carcases are judged from the point of view of their value as fresh pork, and not from the bacon-curer's standpoint. The points appreciated by bacon-curers are very many, and have a direct bearing upon the uses of the pigs for making bacon. Obviously, however, their standard would be altogether a different one from that of the pork-purveyor, who demands the maximum of meat, together with fineness of bone." *

CATTLE-MARKING SCISSORS

Used by cattle salesmen and meat-purveyors for making marks on cattle bought, by which they may be identified.

The reason for reciting these various rules is that no method in connection with judging of meat has so far been generally adopted, and it would appear to be necessary that under our present plan there should be a certain number of points given for each feature indicated, and in this way the judging would be reduced to a complete system.

BUYING CATTLE BY WEIGHT

In many parts of the country the old-fashioned custom of buying and selling live-stock by looking and handling still prevails. *Caveat emptor*, or the buyer's eye, is at the best, however, a very uncertain method of computing value, and, after all, it resolves itself into being in luck or the reverse in a guessing competition. The rules for ascertaining the weight of a live animal by the old-time method have been carefully laid down in the text-books as follows:

"Take the measurement of the girth where it is smallest (close behind the shoulder) and the length of the animal from the front of the shoulder to the juncture of the tail. Multiply the square of the girth in feet and inches by the length in feet, and multiply the product by .23, .24, .26, .28 or .30, according to the fatness of the animal, and the result will give the weight in imperial stones. For instance, if the girth of an animal in moderate condition be 6 ft., the length as above 5 ft. 4 in., then $6 \times 6 = 36 \times 5\frac{1}{3} = 192 \times .24 = 46.08$ stones. The above is the carcase weight of the animal. The weight of the carcase would be about five-eighths of the live weight for cattle; one-half to five-eighths for sheep, and one-half to three-quarters for pigs."

It will readily be seen, however, that to get these measurements with anything like accuracy the animal must hold himself straight while the measuring is taking place, otherwise the length may easily be some inches wrong, and it is difficult to believe that a well-nourished bullock is going to allow himself to be handled all over without shifting his body while the handling is in process.

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* *Scotsman*, December 11, 1908.

By Act of Parliament it is now compulsory to erect cattle-weighing machines at all places where tolls are exacted on the sale of live-stock, and there is no doubt that by the use of the weigh-bridge both the farmer and the butcher get full value for their money.

In China the practice of selling cattle by weight extends back into the dim and distant ages, and we have the authority of Sir Tatton Sykes for the statement that the Egyptians have carried out the same system for over four thousand years. It is interesting to note that one of the sculptures at Thebes shows a bullock standing on a weighing-machine.

In the United Kingdom the system of using the weigh-bridge for live cattle was introduced over half a century ago, more as a guide to the treatment of the animals, and in the experiments carried on by Mr. John Milne, of Dyce, Aberdeenshire, valuable information was secured. He was careful to weigh every particle of food the animals consumed, excepting, of course, the grass they ate from the pastures, and he was able to tell to a nicety at any stage in the history of his animals what return he was receiving for the money expended. As a result of his unique experience, Mr. Milne was able to tell definitely the periods when his animals gave the best return in live weight for the food consumed. It was found that each succeeding pound weight required more food to produce than the previous pound, and simple observation soon told him that it did not pay to keep cattle beyond a certain period.

The Value of Experiments. In the "Transactions of the Highland and Agricultural Society of Scotland" many different experiments are recorded, all showing the advantage of using the weighing-machine in the manipulation of cattle, and it became apparent that if correct data could be secured in the rearing of the animals, similar data should be equally useful to the buyers and killers. In 1886 Mr. R. Henry Rew, of Oxford, read a valuable paper on "Selling Stock by Live Weight" to the members of the Bath and West of England Society, advocating the adoption of weigh-bridges at every place licensed to collect tolls on the sale of live-stock, and his views were incorporated in the *Market and Fairs* (*Weighing Cattle*) *Act of* 1887.

The experiments and painstaking tabulating of data carried out by Mr. John D. McJannet at his Over-Inzievar farm have gone a long way to popularise the system, and it is worth while recording what actually took place under his own supervision. A series of experiments was arranged and carried out on the following lines :

"*The first experiment* (January 12, 1889) was witnessed by a party of thirty farmers from Fifeshire and Stirlingshire ; four fat two-and-a-half-year-old English-bred bullocks were shown, and nine farmers undertook the task of valuing them according to their individual methods. The valuations ranged from £70 10*s*. to £79, the average being £74 0*s*. 6*d*.

I stated that I considered the bullocks were worth 36*s.* per cwt. live-weight; and as the gross weight ascertained in presence of the company was 45 cwt. 21 lb., my estimated value was £81 6*s.* 9*d.*, or £7 6*s.* 3*d.* above the average of my friends' valuations.

"When the animals were sold in Edinburgh ten days later they realised £81 7*s.* 6*d.*

"*The second experiment* (February 2, 1889) was of a similar kind, the visitors being mostly Ayrshire farmers. Four prime fat English-bred bullocks, rising three years old, were the subjects of calculation by nine of the farmers from Ayrshire and two farmers from Clackmannanshire. The highest valuation was £87, and the lowest £65 3*s.* (a difference of £21 17*s.*), the average being £73 10*s.* 10*d.* My own valuation based on the live-weight was £73 10*s.*, and the price the four beasts realised at auction three days afterwards was £73 15*s.* In this case, it will be seen, the weigh-bridge gave at once a result which it required the averaging of eleven farmers' valuations to approximate. A better proof of the value of this implement could not be desired. It gives the benefit of others' experience without the trouble of asking their opinion.

"An experiment of a different character was made at Over-Inzievar on December 14, 1889, when my visitors were asked to estimate the dead-weight of a Canadian bullock. I had never killed one before. The following card was supplied to each of those who undertook the task:

This Canadian bullock was purchased in Glasgow on the 17th July last. Up to the 12th October last he was on pasture, and had always a full bite, but received no cake. Nine weeks ago he was tied up, and put on feeding allowance. During the first fortnight his allowance was irregular; he just got what he ate, but by the 1st day of November he was getting a full allowance of feeding-stuffs, viz., 3 lb. of linseed cake, 3 lb. of cotton cake, $1\frac{1}{2}$ lb. of bruised oats, and $1\frac{1}{2}$ lb. of bruised barley per day, with turnips and oat-straw.

The bullock is about to be slaughtered and dressed by a Glasgow killer, and as the carcase will be weighed *hot*, an allowance of 2 lb. per cwt. for shrinkage, and 5 lb. for tail and kidneys, will be deducted from the weight.

Name........................

Farmer's estimate of the above bullock:

1. His dressed carcase, when cold, should weigh............cwt.........qr.....lb.
2. The bullock would have brought........shillings per cwt., sinking the offal, according to this week's sales.
3. The offal should be as under, viz.:

The hide should weigh..............lb., and worth................
The tallow ,, ... ,, ...
The head ,, ... ,, ...
The feet ,, ... ,, ...
The intestines ,, ... ,, ...
The paunch ,, ... ,, ...
The liver ,, ... ,, ...
The heart ,, ... ,, ...
The tongue ,, ... ,, ...
The blood ,, ... ,, ...
The lungs ,, ... ,, ...
....

Add—Loss in killing ....lb.
.... ,,

Total offal ....

"Only the items 1 and 2 were filled up, no attempt being made to estimate the value or weight of the offal. The bullock was subjected to the usual handling by the examiners, some of whom also applied the tape. All were informed that the animal had lost 35 lb. since the previous night, having been fasted so as to be ready for the butcher. The guessers' cards having been filled up, signed and sealed, the bullock was put on the weigh-bridge, and was found to weigh 11 cwt. 21 lb. After luncheon it was announced that the bullock had been slaughtered, and one of the company was deputed to go and do the weighing, and bring back his report. He did so, and on returning announced that the carcase had been duly dressed and weighed, and after deducting 3 lb. per cwt. on account of its being weighed hot, and 5 lb. for tail and kidneys, the total weight was 6 cwt. 2 qr. 18 lb., or rather over the average percentage of 57 per cent. of live-weight. The papers given in by the different estimators were then opened and examined, when it was found that two had guessed the weight at 5 cwt. 3 qr.; two at 5 cwt. 3 qr. 14 lb.; one had put it at 6 cwt.; another at 6 cwt. 20 lb.: two others had set it down at 6 cwt. 1 qr.; and two others had put it down at 7 cwt. There was thus between the highest and the lowest estimates a difference of 1 cwt. 1 qr., which, at current prices, would amount to over £4. It was also notable that the great majority of estimates were considerably under the true weight of the animal.

"All the farmers present expressed themselves as being greatly impressed with the value of the facts so clearly brought before them, and several of them intimated their intention of providing themselves each with a weigh-bridge without delay.

"Besides the carcase, the offal had been carefully weighed, and was as follows: Hide, 83 lb.; tallow, 73 lb.; head, 27 lb.; feet, 17 lb.; intestines, 129 lb.; paunch, 19¾ lb.; liver, 15 lb.; heart, 5½ lb.; tongue, 6 lb.; blood, 40 lb.; and lungs, 9½ lb. It was explained that the hide would fetch about 4*d.* per lb., or 27*s.* 8*d.* in all; the tallow about 3*d.* per lb., or 18*s.* 3*d.* in all; and the tongue about 6*d.* per lb., or 3*s.* in all; while the head would fetch about 2*s.* 6*d.*, the feet 1*s.*, the intestines, paunch, and lungs about 2*s.* 6*d.*, the liver 1*s.* 6*d.*, the heart 1*s.* 3*d.*, and the blood 1*s.*, making a total of 58*s.* 7*d.* In fact, it may be generally computed that for every hundredweight of dead-weight there was at least 8*s.* worth of offal."

The result of these experiments proves that the guessed valuations would have meant considerable loss in both buying and selling, depending on the figures selected. In the second experiment the valuation of £87 would have meant a big loss to the meat-purveyor while £65 3*s.* would have meant a big loss to the farmer.

There are different standards of weight throughout the United Kingdom, and it is sometimes desirable to be able to see at a glance how one value corresponds to another. We have therefore devised the following Tables for the purposes of handy reference:

READY RECKONER FOR MEAT TRADERS

Per lb.	Per London Stone of 8 lb.		Per Imperial Stone of 14 lb.		Per Score of 20 lb.		Per Cwt.		Per Ton.		
d.	s.	d.	s.	d.	s.	d.	s.	d.	£	s.	d.
1/16		½		⅞		1¼		7		11	8
⅛		1		1¾		2½	1	2	1	3	4
3/16		1½		2⅝		3¾	1	9	1	15	0
¼		2		3½		5	2	4	2	6	8
5/16		2½		4⅜		6¼	2	11	2	18	4
⅜		3		5¼		7½	3	6	3	10	0
7/16		3½		6⅛		8¾	4	1	4	1	8
½		4		7		10	4	8	4	13	4
9/16		4½		7⅞		11¼	5	3	5	5	0
⅝		5		8¾	1	0½	5	10	5	16	8
11/16		5½		9⅝	1	1¾	6	5	6	8	4
¾		6		10½	1	3	7	0	7	0	0
13/16		6½		11⅜	1	4¼	7	7	7	11	8
⅞		7	1	0¼	1	5½	8	2	8	3	4
15/16		7½	1	1⅛	1	6¾	8	9	8	15	0
1		8	1	2	1	8	9	4	9	6	8
1¼		10	1	5½	2	1	11	8	11	13	4
1½	1	0	1	9	2	6	14	0	14	0	0
1¾	1	2	2	0½	2	11	16	4	16	6	8
2	1	4	2	4	3	4	18	8	18	13	4
2¼	1	6	2	7½	3	9	21	0	21	0	0
2½	1	8	2	11	4	2	23	4	23	6	8
2¾	1	10	3	2½	4	7	25	8	25	13	4
3	2	0	3	6	5	0	28	0	28	0	0
3¼	2	2	3	9½	5	5	30	4	30	6	8
3½	2	4	4	1	5	10	32	8	32	13	4
3¾	2	6	4	4½	6	3	35	0	35	0	0
4	2	8	4	8	6	8	37	4	37	6	8
4¼	2	10	4	11½	7	1	39	8	39	13	4
4½	3	0	5	3	7	6	42	0	42	0	0
4¾	3	2	5	6½	7	11	44	4	44	6	8
5	3	4	5	10	8	4	46	8	46	13	4
5¼	3	6	6	1½	8	9	49	0	49	0	0
5½	3	8	6	5	9	2	51	4	51	6	8
5¾	3	10	6	8½	9	7	53	8	53	13	4
6	4	0	7	0	10	0	56	0	56	0	0
6¼	4	2	7	3½	10	5	58	4	58	6	8
6½	4	4	7	7	10	10	60	8	60	13	4
6¾	4	6	7	10½	11	3	63	0	63	0	0
7	4	8	8	2	11	8	65	4	65	6	8

Ready Reckoner for Meat Traders—*continued*

Per lb.		Per London Stone of 8 lb.		Per Imperial Stone of 14 lb.		Per Score of 20 lb.		Per Cwt.		Per Ton.		
s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	£	*s.*	*d.*
	7¼	4	10	8	5½	12	1	67	8	67	13	4
	7½	5	0	8	9	12	6	70	0	70	0	0
	7¾	5	2	9	0½	12	11	72	4	72	6	8
	8	5	4	9	4	13	4	74	8	74	13	4
	8¼	5	6	9	7½	13	9	77	0	77	0	0
	8½	5	8	9	11	14	2	79	4	79	6	8
	8¾	5	10	10	2½	14	7	81	8	81	13	4
	9	6	0	10	6	15	0	84	0	84	0	0
	9¼	6	2	10	9½	15	5	86	4	86	6	8
	9½	6	4	11	1	15	10	88	8	88	13	4
	9¾	6	6	11	4½	16	3	91	0	91	0	0
	10	6	8	11	8	16	8	93	4	93	6	8
	10¼	6	10	11	11½	17	1	95	8	95	13	4
	10½	7	0	12	3	17	6	98	0	98	0	0
	10¾	7	2	12	6½	17	11	100	4	100	6	8
	11	7	4	12	10	18	4	102	8	102	13	4
	11¼	7	6	13	1½	18	9	105	0	105	0	0
	11½	7	8	13	5	19	2	107	4	107	6	8
	11¾	7	10	13	8½	19	7	109	8	109	13	4
1	0	8	0	14	0	20	0	112	0	112	0	0
1	0¼	8	2	14	3½	20	5	114	4	114	6	8
1	0½	8	4	14	7	20	10	116	8	116	13	4
1	0¾	8	6	14	10½	21	3	119	0	119	0	0
1	1	8	8	15	2	21	8	121	4	121	6	8
1	1¼	8	10	15	5½	22	1	123	8	123	13	4
1	1½	9	0	15	9	22	6	126	0	126	0	0
1	1¾	9	2	16	0½	22	11	128	4	128	6	8
1	2	9	4	16	4	23	4	130	8	130	13	4
1	2¼	9	6	16	7½	23	9	133	0	133	0	0
1	2½	9	8	16	11	24	2	135	4	135	6	8
1	2¾	9	10	17	2½	24	7	137	8	137	13	4
1	3	10	0	17	6	25	0	140	0	140	0	0
1	3¼	10	2	17	9½	25	5	142	4	142	6	8
1	3½	10	4	18	1	25	10	144	8	144	13	4
1	3¾	10	6	18	4½	26	3	147	0	147	0	0
1	4	10	8	18	8	26	8	149	4	149	6	8
1	4¼	10	10	18	11½	27	1	151	8	151	13	4
1	4½	11	0	19	3	27	6	154	0	154	0	0
1	4¾	11	2	19	6½	27	11	156	4	156	6	8
1	5	11	4	19	10	28	4	158	8	158	13	4

READY RECKONER FOR MEAT TRADERS—*continued*

Per lb.		Per London Stone of 8 lb.		Per Imperial Stone of 14 lb.		Per Score of 20 lb.		Per Cwt.		Per Ton.		
s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	£	*s.*	*d.*
1	5¼	11	6	20	1½	28	9	161	0	161	0	0
1	5½	11	8	20	5	29	2	163	4	163	6	8
1	5¾	11	10	20	8½	29	7	165	8	165	13	4
1	6	12	0	21	0	30	0	168	0	168	0	0
1	6¼	12	2	21	3½	30	5	170	4	170	6	8
1	6½	12	4	21	7	30	10	172	8	172	13	4
1	6¾	12	6	21	10½	31	3	175	0	175	0	0
1	7	12	8	22	3	31	8	177	4	177	6	8
1	7¼	12	10	22	5½	32	1	179	8	179	13	4
1	7½	13	0	22	9	32	6	182	0	182	0	0
1	7¾	13	2	23	0½	32	11	184	4	184	6	8
1	8	13	4	23	4	33	4	186	8	186	13	4
1	8¼	13	6	23	7½	33	9	189	0	189	0	0
1	8½	13	8	23	11	34	2	191	4	191	6	8
1	8¾	13	10	24	2½	34	7	193	8	193	13	4
1	9	14	0	24	6	35	0	196	0	196	0	0
1	9¼	14	2	24	9½	35	5	198	4	198	6	8
1	9½	14	4	25	1	35	10	200	8	200	13	4
1	9¾	14	6	25	4½	36	3	203	0	203	0	0
1	10	14	8	25	8	36	8	205	4	205	6	8
1	10¼	14	10	25	11½	37	1	207	8	207	13	4
1	10½	15	0	26	3	37	6	210	0	210	0	0
1	10¾	15	2	26	6½	37	11	212	4	212	6	8
1	11	15	4	26	10	38	4	214	8	214	13	4
1	11¼	15	6	27	1½	38	9	217	0	217	0	0
1	11½	15	8	27	5	39	2	219	4	219	6	8
1	11¾	15	10	27	8½	39	7	221	8	221	13	4
2	0	16	0	28	0	40	0	224	0	224	0	0

TABLES OF LIVE AND DEAD WEIGHT OF FAT CATTLE AND SHEEP *

The following Tables have been prepared from actual data, arrived at by weighing fat bullocks before being killed, then weighing the carcases when the animal heat has been exhausted. The cattle were all well-finished animals, fed on cakes and meals in addition to their ordinary foods.

To suit farmers and feeders of fat stock in different districts, the dead weight is shown in three different ways, viz., (1) in cwt. qr. lb.; (2) in stones and lb.; (3) in lb. only.

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* Reproduced by permission of Mr. John D. M'Jannet, Woodlands, Stirling.

The animals were unfasted before being killed.

Live Weight.			Dead Weight in						Live Weight.			Dead Weight in					
Cwt.	Qr.	Lb.	Cwt.	Qr.	Lb.	Stns.	Lb.	Lb.	Cwt.	Qr.	Lb.	Cwt.	Qr.	Lb.	Stns.	Lb.	Lb.
7	0	0	4	0	0	32	0	448	11	0	0	6	1	4	50	4	704
7	0	14	4	0	8	32	8	456	11	0	14	6	1	12	50	12	712
7	1	0	4	0	16	33	2	464	11	1	0	6	1	20	51	6	720
7	1	14	4	0	24	33	10	472	11	1	14	6	2	0	52	0	728
7	2	0	4	1	4	34	4	480	11	2	0	6	2	8	52	8	736
7	2	14	4	1	12	34	12	488	11	2	14	6	2	16	53	2	744
7	3	0	4	1	20	35	6	496	11	3	0	6	2	24	53	10	752
7	3	14	4	2	0	36	0	504	11	3	14	6	3	4	54	4	760
8	0	0	4	2	8	36	8	512	12	0	0	6	3	12	54	12	768
8	0	14	4	2	16	37	2	520	12	0	14	6	3	20	55	6	776
8	1	0	4	2	24	37	10	528	12	1	0	7	0	0	56	0	784
8	1	14	4	3	4	38	4	536	12	1	14	7	0	8	56	8	792
8	2	0	4	3	12	38	12	544	12	2	0	7	0	16	57	2	800
8	2	14	4	3	20	39	6	552	12	2	14	7	0	24	57	10	808
8	3	0	5	0	0	40	0	560	12	3	0	7	1	4	58	4	816
8	3	14	5	0	8	40	8	568	12	3	14	7	1	12	58	12	824
9	0	0	5	0	16	41	2	576	13	0	0	7	1	20	59	6	832
9	0	14	5	0	24	41	10	584	13	0	14	7	2	0	60	0	840
9	1	0	5	1	4	42	4	592	13	1	0	7	2	8	60	8	848
9	1	14	5	1	12	42	12	600	13	1	14	7	2	16	61	2	856
9	2	0	5	1	20	43	6	608	13	2	0	7	2	24	61	10	864
9	2	14	5	2	0	44	0	616	13	2	14	7	3	4	62	4	872
9	3	0	5	2	8	44	8	624	13	3	0	7	3	12	62	12	880
9	3	14	5	2	16	45	2	632	13	3	14	7	3	20	63	6	888
10	0	0	5	2	24	45	10	640	14	0	0	8	0	0	64	0	896
10	0	14	5	3	4	46	4	648	14	0	14	8	0	8	64	8	904
10	1	0	5	3	12	46	12	656	14	1	0	8	0	16	65	2	912
10	1	14	5	3	20	47	6	664	14	1	14	8	0	24	65	10	920
10	2	0	6	0	0	48	0	672	14	2	0	8	1	4	66	4	928
10	2	14	6	0	8	48	8	680	14	2	14	8	1	12	66	12	936
10	3	0	6	0	16	49	2	688	14	3	0	8	1	20	67	6	944
10	3	14	6	0	24	49	10	696	14	3	14	8	2	0	68	0	952

Inferior Cattle dress *less* than these figures.
Prime Cattle dress *more* than these figures.
Condition must remain a matter of judgment.

Live and Dead Weight of Fat Sheep

"During the last five years I have regularly killed at my farm prime fat sheep, as under. The sheep were taken from the field, selected from a lot, instantly weighed alive, then killed, and twenty-four hours after slaughter, the carcases, without head and pluck, were weighed, with the following results, viz.,

When Killed.	Description.	Unfasted Live Weight.	Per cent. of Mutton.		Average of all killed by me.
		Lb. Lb.	Lowest	Highest	Per cent.
May to August	Three-part lambs	60– 90	49	52	50
November to Jan.	Three-part hoggets	90–120	50	54	51
February to July	Cross-bred hoggs	120–135	52	56	53
July to October	Half-bred ewes	140–180	50	53	51
November to Feb.	Blackfaced ewes	116–136	50	52.7	51

NOTE. During twenty-four hours' fasting or journeying to market I found, by weighing them on the market steelyard, that my lambs lost 7 lb., my hoggets 10 lb., my hoggs 9 lb., and my big half-bred ewes 12 lb., and the blackfaced ewes 8 lb., in live weight. The hoggs and ewes were clipped in May.

"JOHN D. M'JANNET.

"STIRLING, *November* 27, 1893."

Extracts from Markets and Fairs (Weighing of Cattle) Acts, 1887 and 1891.

2. (1) The market authority of every market and fair to which the principal Act for the time being applies shall, unless exempted by order of the Board of Agriculture from the requirements of the section, provide and maintain to the satisfaction of the Board, sufficient and suitable accommodation for weighing cattle.

(2) Default in complying with the requirements of this section shall be deemed default in complying with the requirements of section 4 of the principal Act.

4. (1) An auctioneer shall not, unless exempted by order of the Board of Agriculture from the requirements of this section, sell cattle at any mart where cattle are habitually or periodically sold, unless there are provided at that mart similar facilities for weighing cattle, as are required by the principal Act and this Act in the case of cattle sold at a market or fair to which the principal Act applies.

(3) If any such auctioneer makes default in complying with the requirements of this section, the auctioneer, or if he is in the employment of any person, the person by whom he is employed, shall for each offence be liable on summary conviction to a fine not exceeding £20, or in a case of a continuing offence, to a fine not exceeding £10 for every day during which the offence continues.

5. Every person selling, offering for sale, or buying any cattle in a market provided with accommodation for weighing cattle, may require such cattle to be weighed.

6. Every person appointed by the market authority to weigh cattle sold in the market or fair, who—

(*a*) refuses or neglects to weigh the same when required ; or

(*b*) refuses or neglects to deliver to the seller or buyer a ticket specifying the true weight of the cattle weighed ; or

(*c*) gives to any person a false ticket or account of any cattle weighed ;

shall be liable on summary conviction, to a fine not exceeding forty shillings, and not less than half a crown.

7. Every person who knowingly acts or assists in committing any fraud respecting the weighing of any cattle weighed in pursuance of this Act, shall, for every such offence, be liable on summary conviction to a fine not exceeding £5.

In this Act the word " cattle " includes ram, ewe, wether, lamb and swine.

A NOTABLE PROVINCIAL CATTLE-MARKET

Amongst the provincial cattle-markets of the United Kingdom, there is no better example of what a modern place of that kind should be than the market belonging to the town of Market Harborough, and the following description * gives a very good idea of how it came into existence, as well as details of the structural work, which might serve as a model to others.

It must be evident to any one that the first name in Market Harborough points to its having been looked upon in the past as an important market town. In 1219, in the reign of Henry III., we find an entry in the Close Rolls referring to Harborough Market; and another in 1221, wherein the king allows Harborough Market to be changed from Monday to Tuesday, on which day it is still held. From the town documents of the time of Henry VI. we learn that Harborough once had a market cross; but it was taken down in 1615, for which the townsmen paid the workmen 1*s.* 8*d.* and 4*d.* for carrying the cross stones to the "ram" yard.

Old Market-place. Previous to the building of the new market, in 1903, the markets were held in the streets of the town from time immemorial; and until a recent date what is now known as "The Square" was called the "Sheep Market," because here were penned sheep, pigs and calves. The high street was used as a pitch for cattle. The condition of Market Harborough in the past on a market day may be imagined, and more especially on a Fair Day, when perhaps upwards of two thousand beasts would be in possession. It had been the privilege of the Lords of the Manor to take tolls on all animals coming into the town on a market day, but in 1874 a gentleman freed the owners of the cattle from the obligation by the payment of a lump sum to the Lord of the Manor. The exaction of the tolls had in past times carried with it certain duties on the part of the lord, including the protection of the stock and persons using the market, and probably the cleansing of the streets. But these duties gradually disappeared, and the public authorities had the expense thrown upon them.

Market Harborough is situated in the rich feeding-land of the Welland Valley. A ploughed field is the exception, and as there is so much grassland on which beasts may be grazed and fattened, it is not surprising that the establishment of a market became an obvious necessity. Two very important and well-attended cattle fairs are held annually—one in October and the other in April—the average number of beasts pitched being from 1800 to 2000 at each.

New Market-place. Such then were the conditions when, in August 1900, a poll of the inhabitants was taken as to whether the council should or should not purchase the market rights, and establish a proper up-to-date market-place other than in the streets of the town. The poll resulted

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* From a paper by Mr. Herbert G. Coales, Engineer and Surveyor, Urban District Council, Market Harborough, reported in the "Surveyor" of May 19, 1905. We are also indebted to Mr. Coales for the use of the illustrations.—AUTHORS.

Market Harborough Cattle-markets

The Cattle-pens at Market Harborough Cattle-markets

Another View of Market Harborough Cattle-markets, showing the Lodge and Entrance-gates in 858 voting for the purchase and 739 against. Negotiations were entered into with Lord Barnard, the present Lord of the Manor, and the market rights were purchased for £2455, and twelve acres of grass-land in a central and accessible position at the very moderate price of under £300 per acre, or a total of £5967 for the market rights and the land.

A plot of building land was also acquired on the St. Mary's Road for £600, by which the proposed new market could be connected by a bridge with the main thoroughfare leading to the joint railway station, should it in the future be found desirable so to do. In addition, Lord Barnard presented the fair tolls to the town.

The site is served by three roads—Springfield Street on the south, Kettering Road on the east, and Northampton Road for a short length on the west. The northern boundary is for the most part the River Welland. The distance from the centre of the town is 200 yards, and 700 yards from the joint station of the Midland and London and North-Western Railways.

The six acres of land nearest the town are laid out for the market proper, the remaining six acres being used for open lairages for the stock attending the market. There are three entrances, the principal one, and the nearest to the town, being from the Northampton Road, whereat sheep, calves and pigs are admitted; the other two entrances are both from Springfield Street, for the use of beast and horses. The shedding, placed on the north side of the site, affords as much shelter as possible for the market from cold winds.

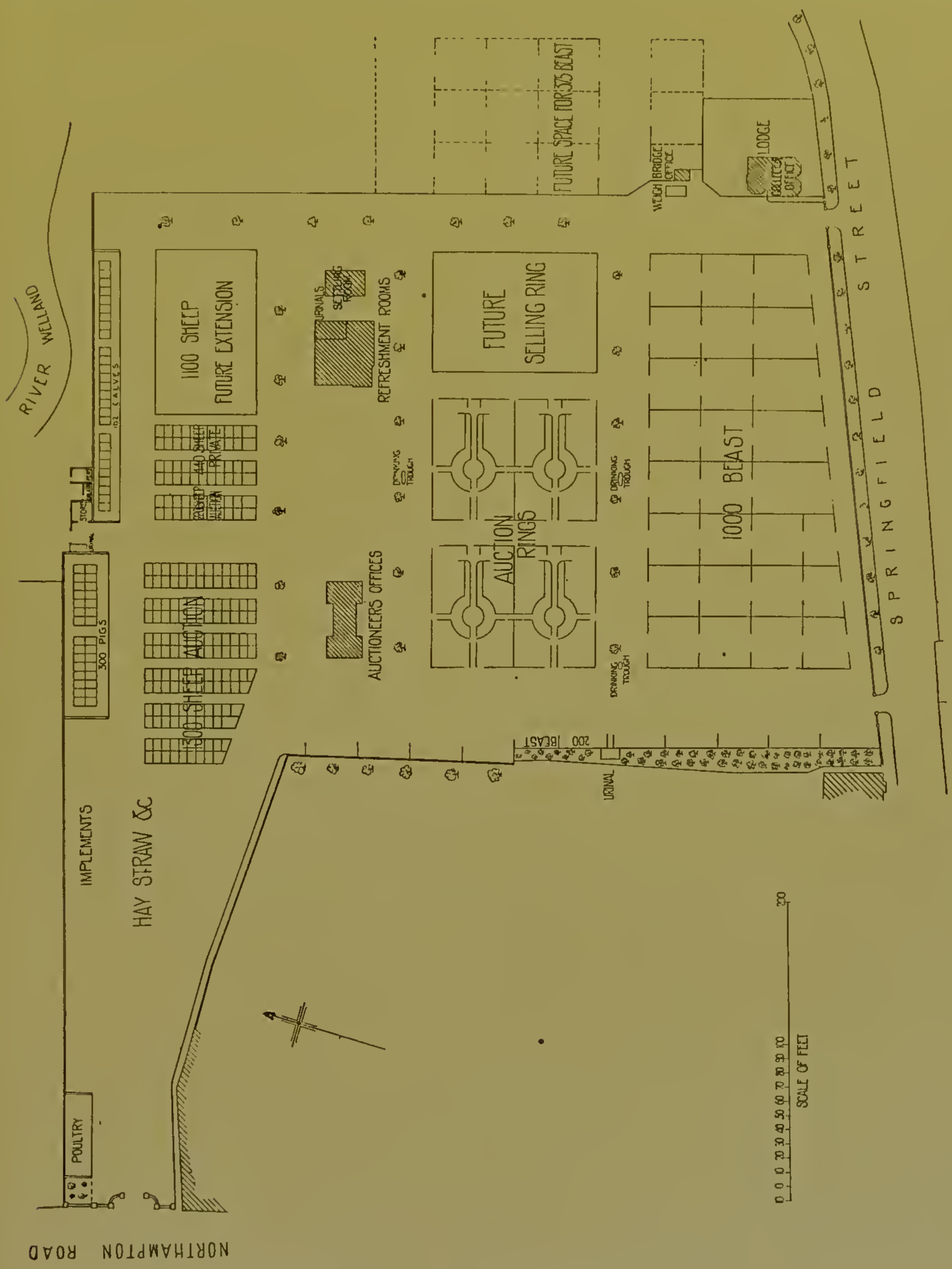
Accommodation. The following pen-accommodation is provided: 1200 cattle to be sold privately, 400 cattle to be sold by auction, 440 sheep to be sold privately, 1720 sheep to be sold by auction, 300 pigs in shed, and 162 calves in shed.

In addition, there is a shed for poultry, and a space set apart for a show-ground for horses; also a pitch for agricultural implements, hay, roots, &c. A good deal more stock can be accommodated than indicated above during fairs, or on emergency, on the roads and open spaces of the market.

Accommodation for Auctioneers. There are four sale-rings for cattle, designed with a view to the convenience of buyers, who can readily see the animals as they are passed along to the selling ring without incurring any danger of injury from them. The iron fencing and paving are as described for the other cattle-pens, with the addition of gates and gullies as required. A plank is fixed along the centre of the sheep-pens above the fencing, from which the auctioneer sells. Auctioneers' offices are built in the centre of the market between the sheep- and the beast-pens, and each is let on lease at £10 per annum.

Levels. The northern and eastern parts of the land, being liable to floods, were made up to above flood-level with surplus earth excavated from the southern and western parts. The fields had originally a fall of 5 ft. from the south-west to the north-east corners; now the fall is

2 ft., or a gentle gradient of 1 in 335. In addition to bringing the surface of the market above flood-level, the river on the northern boundary was widened its whole length and the bends piled with old railway sleepers.



Plan of Cattle-market at Market Harborough

Drainage. All the drains are connected with the town sewers, with a penstock arrangement for turning the water into the river on other than market or cleaning days, the sewage farm having quite enough sewage to filter without the addition of the rainfall from six acres of paved surface. The main drains are 9 in. and 6 in. in diameter, with inspection chambers at frequent intervals. Where there appeared a likelihood of the tree-roots getting into the drains the latter were concreted.

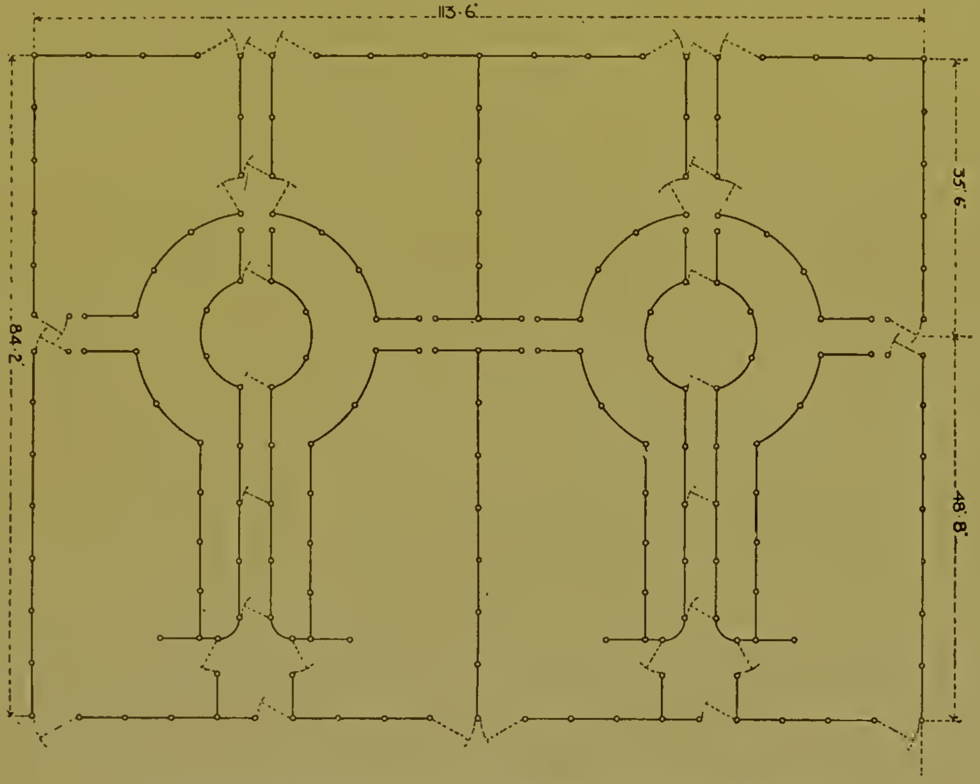
Water-mains. Two systems of water-mains are laid in the market —one, a 3-in. service from the high-pressure town water-main in Springfield Street to a fire hydrant near the centre of the market, and from which drinking water is supplied to the refreshment-rooms ; and the other, a 6-in. low-pressure main, with 3-in. branches, from an auxiliary supply for cleansing the market. Sluice hydrants are placed on the low-pressure mains in suitable positions all over the market, for the ready cleansing of its surface. Stoneware drinking-troughs are placed in the centres of the roads, for providing the cattle with water.

Gas-mains. Three-inch mains are laid through the market, from which the buildings are supplied with gas. There are no outside lamps required, the market being over long before dusk.

Roads. The main roads are 36 ft. and 40 ft. in width, and of tar macadam. The foundation is of furnace slag, 8 in. thick, hand-pitched and steam-rolled. The tar macadam is 4 in. thick, composed of 2-in. broken furnace slag, dried on hot plates, mixed with boiling tar and a little pitch, also steam-rolled, and finished with a ½-in. top layer of ⅜-in. granite chippings and boiled tar, well steam-rolled. The roads were completed by a slight sprinkling of fine granite chippings. The cost of the roads complete was 3*s*. 3*d*. per square yard. Two roads are made of ordinary Leicestershire granite macadam 4 in. thick, with an 8-in. slag foundation similar to above. The cost of the macadam roads complete was 2*s*. 7*d*. per square yard. One of these roads is for showing horses on, and on the other implements, loads of hay, and miscellaneous goods may be pitched.

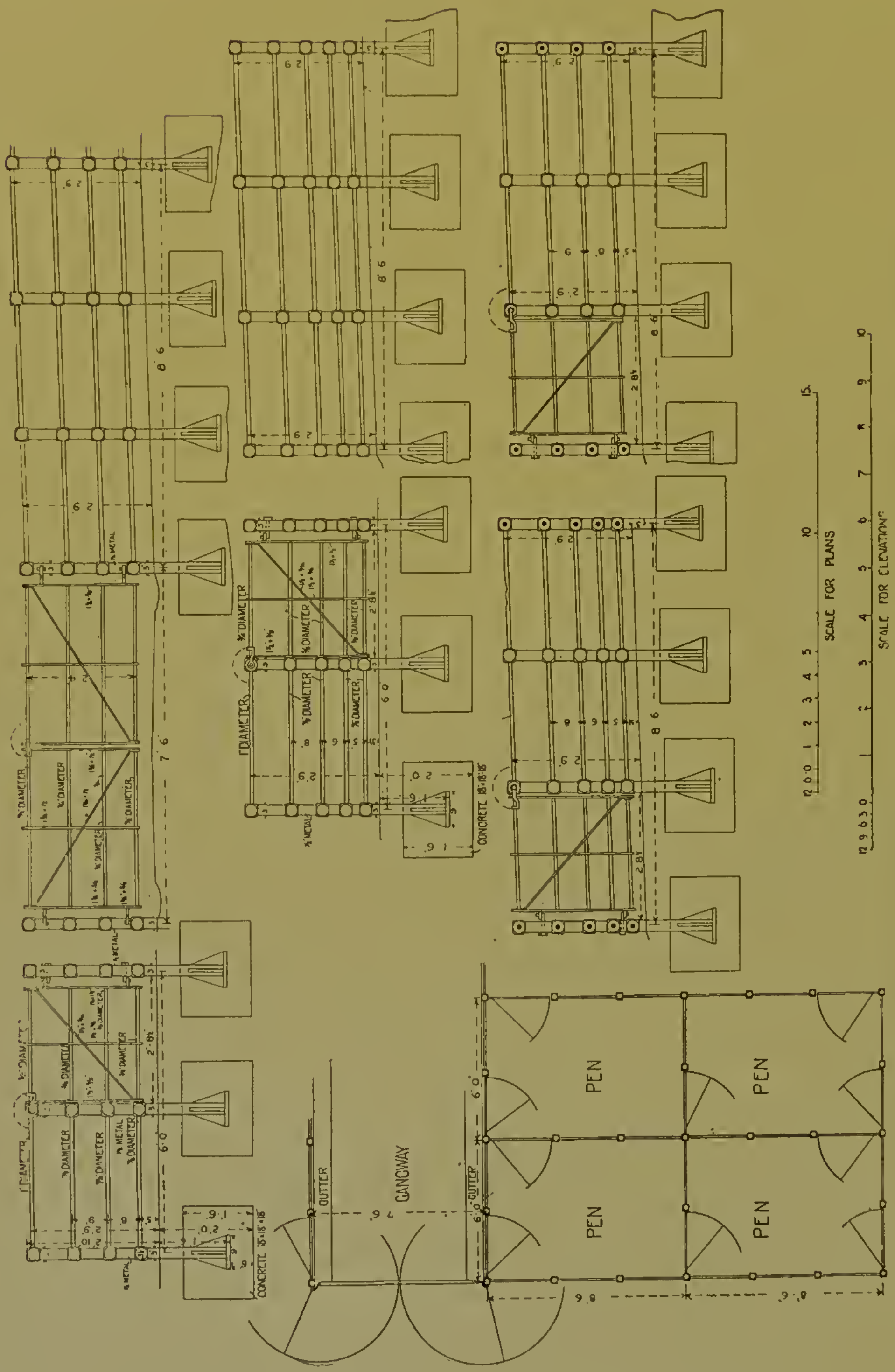
Trees. A bank on the western boundary, formed in the process of levelling the site, is planted with shrubs and trees. Lime-trees are planted about twenty yards apart on the centres of the main roads, partly for adornment and partly for providing shade. The trees were purposely planted away from the pens, to prevent the roots from lifting the paving. The trees are protected with specially stout iron guards ; and the tar macadam is made good round the trees with 5 in. × 10 in. concrete kerbs.

Construction of Pens. *Cattle-pens.* The store cattle (chiefly Welsh, and Irish) are held up by drovers in open pens, a 12-ft. gangway running up the centre of each bay. The pens are 36 ft. long and 12 ft. deep. The cast-iron posts, placed 6 ft. apart, weigh 3½ cwt. each, and are fixed in the ground with Portland cement concrete. The rails are five in number, of 1½-in. solid round bar-iron ; the lowest is 1 ft. 3¼ in. from the ground, and the others 10¼ in. from centre to centre, the top rail being 4 ft. 10 in. high. The rails are keyed into the posts with iron keys. Solid bars were used in preference to tubular, as being easier to straighten in case of damage. The cost of the fencing complete, including excavation, concrete and painting, was £1 2*s*. 3*d*. per yard lineal. The paving of the pens and gangways is of dressed random granite setts, grouted in cement, on 2-in. bed of granite gravel, with a 6-in. foundation of lime concrete mixed 1 to 6. The cost of the paving complete was 7*s.* 6*d.* per square yard. The setts give a very good foothold to the cattle, much better than concrete or blue bricks. Dressed random setts are only about two-thirds the cost of dressed setts, and are quite good enough for the purpose. The cross-fall of each pen is 4 in. A channel is formed on either side of the central gangway, which is 2 in. higher than the channels. The longitudinal fall of the pens is about 1 in 300, and there are no drains in or under the pens: the channels convey the water to gullies placed in the main roads. Each single pen will accommodate eighteen beasts, allowing 2 ft. in width per beast, the space suggested in the model bylaws of the Local Government Board.

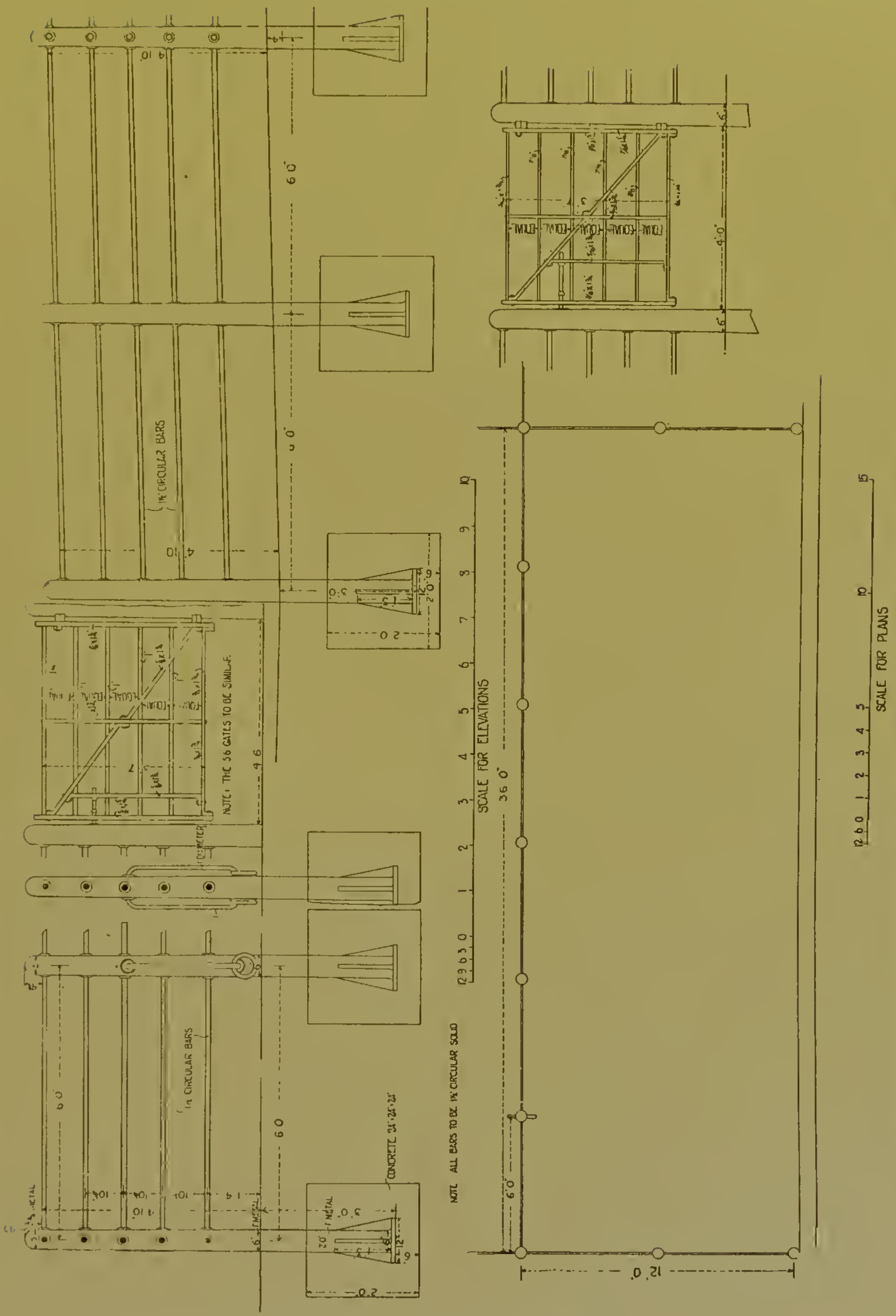


Plan of the Auction-rings at Market Harborough

Sheep-pens. The sheep-pens are in double rows, all intercommunicating by gates, with a gangway 7 ft. 6 in. wide between the blocks. Each pen is 8 ft. 6 in. × 6 ft. The cast-iron posts weigh 100 lb. each and are concreted in the ground. The rails are four in number, keyed to the posts; the top rail is 1 in. round bar-iron, 2 ft. 9 in. from the ground; the other rails are ⅞ in. round bar-iron, 10½ in., 9 in. and 8 in. apart respectively from centre to centre. The cost of the fencing complete, including gates, excavation, concrete and painting, was 12*s.* 7*d.* per yard lineal. The gates are secured with turnover fastenings. The paving is of Portland cement concrete, mixed on the average thickness of 1 to 3, laid *in situ* 3 in. thick, on a 4-in. bed of broken rubble, with herring-bone grooving in the pens, the gangways being smooth. The cost of the paving complete was 4*s.* per square yard. The cross-fall of



Market Harborough Cattle-market. Details of Construction of Sheep-pens



Market Harborough Cattle-market. Details of Construction of Cattle-pens each pen is 3 in. The method of draining is as described for the beast-pens. Each pen will hold twelve sheep, allowing 4 ft. superficial to each sheep.

Covered Pig-pens. The pig-pens are of the same size and constructed in a similar manner to the sheep-pens, but with five rails instead of four to keep in the small pigs. The pig-shed is 114 ft. long by 30 ft. wide 9 ft. 3 in. high to wall-plate. The roof is tiled, and supported by steel principals on cast-iron columns, 11 ft. 4 in. apart, and 14-in. common brick back and end walls. A 5-ft. north light, of W. H. Heywood and Co.'s glazing, runs the entire length of the shed, so that an abundance of light is provided.

Covered Calf-pens. The calf-pens are a single row of 8 ft. 6 in. by 6 ft.; the fencing and paving are similar in every respect to the sheep-pens. The calf-shed is 188 ft. long by 18 ft. wide and 9 ft. 3 in. high to the wall-plate, and similar to the pig-shed, except that the roof principals are of wood.

Covered Poultry-pens. The poultry-shed, 60 ft. long by 18 ft. wide, is similar in construction to the calf-shed. The building is provided with wooden pens with wire fronts.

The Subsidiary Buildings. In the centre of the market is a block of buildings, comprising first- and second-class refreshment-rooms, with cellarage underneath, and upstairs a kitchen, scullery and larder over the second-class bar, with a dining-room (used at present as a settling-room) over the other bar. A clock tower is carried up at the south-west corner of the block. At the north-east corner of the block a suite of first- and second-class lavatories is provided. The arms of the Earls of Harborough are carved on the clock tower, the council having first obtained permission to use them as the town arms while the market was in course of erection.

Near to the refreshment-rooms is a one-storey building, 25 ft. long × 18 ft. wide, used as a settling-room by persons not caring to settle on licensed premises. It also answers the purpose of a corn exchange, being provided with merchants' stands.

A house for the superintendent is built near the eastern entrance in Springfield Street, with an office for his use attached.

A seven-ton weigh-bridge is erected, with a little weigh-office, near the superintendent's house, fitted with movable railings for cattle-weighing.

Isolation pens for cattle and sheep are provided between the river and the calf-shed for the isolation of animals discovered in the market to be infected with contagious disease.

In addition to the urinals and water-closets provided in the central building, two other blocks of urinals are provided at convenient positions in the market—one near the beast-pens to the west, and the other near the sheep-pens to the north.

The boundary walls, abutting on the streets, are of 14-in. brick, with Weldon stone coping and wrought-iron unclimbable fencing; total, height of brickwork and fence, 8 ft. The specially designed wrought-iron entrance gates are hung to Weldon stone carved piers.

The work was let in five contracts:

	£	s.	d.
Nos. 1 and 4. Laying-out, drainage, road-making and paving	8,125	0	3
No. 2. Ironwork	2,965	17	5
No. 3. Buildings	6,589	9	10
No. 4*a*. Concrete paving	576	6	2
Additional fencing and water-mains, &c.	524	19	9
Total cost of works	£18,781	13	5

The total outlay on the market, including land, purchase of rights, and works, was £25,950.

The market has been designed with a view to future extensions, fenced-in spaces being reserved for additional beast- and sheep-pens, the provision of which will not in any way disturb the existing roads or arrangements.

The result of the first two years' working was as follows:

—	Year ending March 31.	
	1904.	1905.
Beasts	20,495	22,504
Horses	518	441
Sheep	23,751	26,730
Calves	1,123	1,134
Pigs	2,360	2,430
Poultry (couples)	1,543	1,601

LIST OF SOME OF THE TOLLS LEVIABLE IN THE MARKET

Cattle.

For every bull	6*d*.
,, ox, cow, steer, yearling or heifer	3*d*.
,, calf	1*d*.

Sheep and Goats.

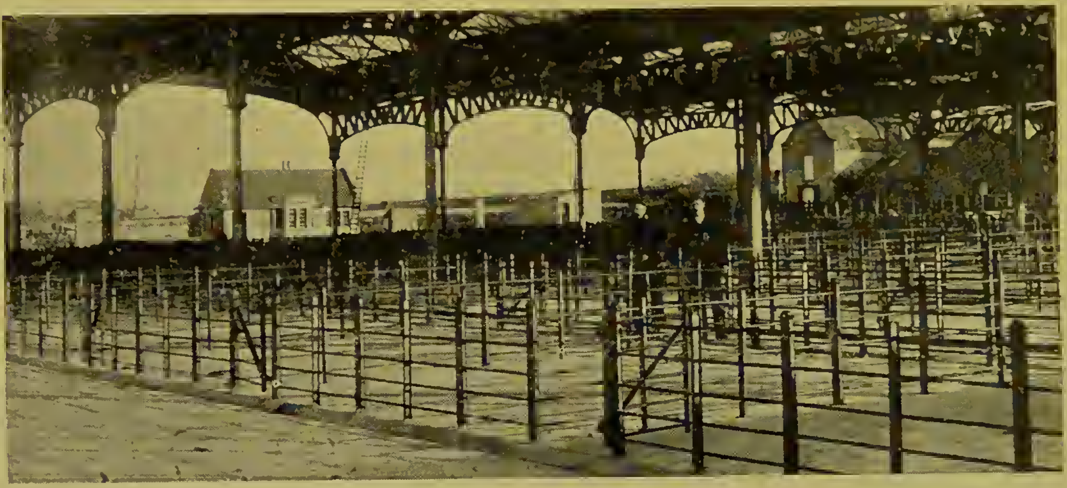
For every ram	3*d*.
,, sheep or weaned lamb, goat or weaned kid	1*d*.

Pigs.

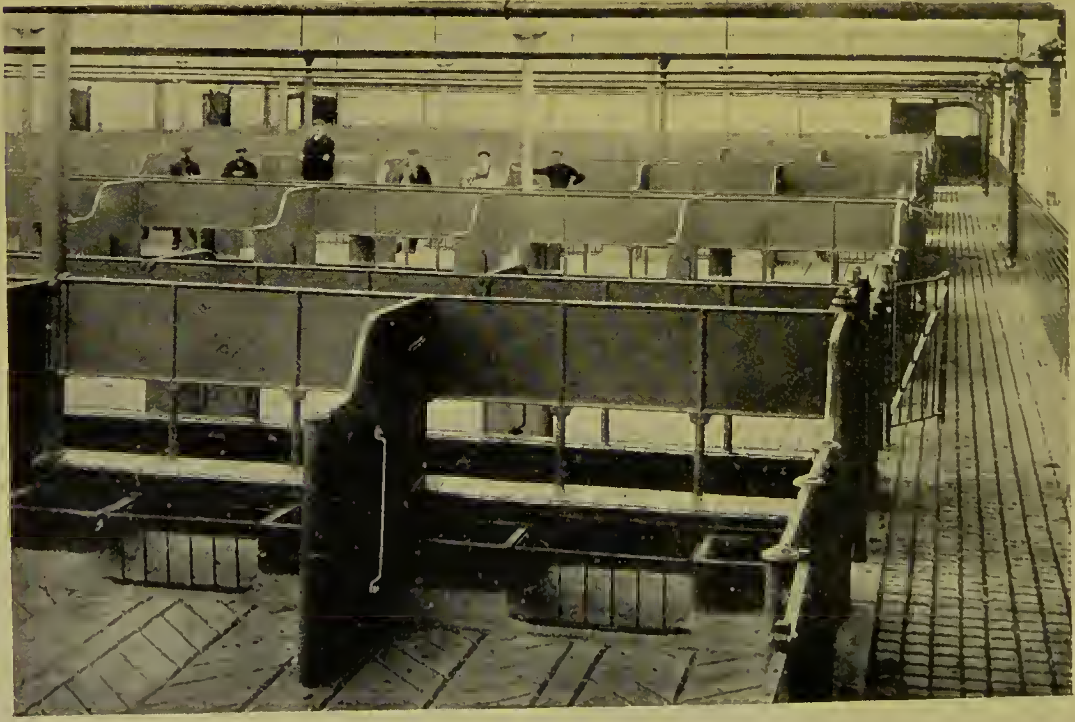
For every sow and her litter or farrow	6*d*.
,, fat pig	2*d*.
,, other pig	1*d*.

Auctions.—When such animals or marketable commodities are sold by auction, tolls double the above amounts shall also be paid in addition to the tolls hereinbefore prescribed.

THE COVERED AREA IN WHICH THE MARKETS ARE HELD



VIEW OF THE PENNAGE FROM THE NORTH-WEST. BYRE SEEN TO THE RIGHT, OFFICE IN FRONT



GENERAL VIEW OF THE CATTLE-BYRE

There is a passage at each end of the cattle bays, allowing for animals being taken to the auction-ring by the one way and returning to the stance by the other. The building is built up with 5 ft. or 6 ft. of brown glazed brick, above that is common brick pointed inside and plastered outside with rough-cast. In cold weather the byre can be heated.

CHAPTER III

ABATTOIRS

We have already seen that the origin of the meat industry as a recognised art was coincident with the beginnings of civilisation, but the methods adopted for the slaughter of animals for food have varied very much in different ages. It is not, however, until the fourteenth century that we have any tangible records of public abattoirs being established or being placed under public control, and while this remark applies to the United Kingdom it also applies to Germany, where, about the same time, laws were enacted governing the establishment and use of public abattoirs. It must be said that in this respect progress has been very slow in the United Kingdom, and at the present time the number of public abattoirs in existence is wholly inadequate to the requirements of the country.

In England and Wales there are something like one hundred public abattoirs, and the remainder of the slaughtering is conducted in private establishments. It will, therefore, serve our purpose here to consider the two different kinds of slaughterhouses separately.

Before proceeding, however, to do this, it will be of interest to refer to the fact that the institution of public abattoirs is much more advanced in Scotland than in any other part of the United Kingdom. It would appear * that the General Police and Improvement (Scotland) Act of 1862 and the Burgh Police (Scotland) Act of 1892 have largely been taken advantage of, and also local Acts have been obtained so as to enable public abattoirs to be constructed.

Prior to any such legislation, it is notable that in Scotland the Fleshers' Incorporations of such cities as Edinburgh, Glasgow, Perth and Aberdeen were the nominal owners of public abattoirs, which entirely took the place of private establishments.

A Demand for Public Slaughterhouses. In the *Scotsman* newspaper of January 29, 1849, there appeared an interesting communication on "The Necessity for Public Slaughterhouses," which throws an interesting light on public opinion on this matter at that date, and it is, therefore, quoted here as typical of the views which were then held in the rest of Scotland :

" In a pamphlet published in 1847, by the Inspector of Lighting and Cleaning, the necessity of erecting public slaughterhouses was strongly urged, and every circumstance which has subsequently occurred in connection with the flesher trade has tended to prove that it is in the interest of the dealer, as well as of the consumer, that a change in the present vicious system should be speedily effected. Mr. Murray states that the slaughterhouses, formerly the property of the Incorporation of Fleshers, were considered a nuisance ; but since these killing-places have been taken down, in consequence of railway operations, slaughterhouse nuisances have increased throughout the bounds of police. The trade of flesher is carried on by about one hundred and fifty different persons, who use seventy-eight killing-booths—one booth occasionally serving three or four individuals. There are clusters of slaughterhouses at Livingston's Yard, Causewayside, and in Parks Work, Canongate ; and other killing-places are spread over the whole city—one and all being so many nuisances. It may be remarked also that the killing of animals is not confined to the slaughterhouses referred to, almost every flesher killing calves, sheep and lambs, in the back parts of his sale shop or cellar adjoining. There are also other important considerations connected with the subject in addition to the matter of nuisance. It would be unjust to impute blame to any one for a state of things which had been induced by circumstances, and it would be equally uncandid not to state that an attempt was last year made by the Lord Provost and magistrates in the Police Bill introduced by them into Parliament, to take powers to correct the evil, and as the trade and civic authorities had made a definite arrangement on the subject, it is to be regretted that the clauses of the dropped Bill which related to slaughterhouses were not pressed, even though the other portions of the Bill were abandoned—for it is obvious that application must, at no very distant day, be made to the Legislature for authority to erect abattoirs, as those establishments are designated in France ; and the principle adopted to procure the 'ways and means' to erect the new Corn Exchange, now in the course of building, seems excellent. The ancient 'Corporation of Fleshers,' with all its rights and privileges, is practically extinct, and it can scarcely be expected that 'the trade,' as now constituted, will undertake the responsibility of applying for and obtaining from Parliament the requisite powers ; and it were idle to attempt any large measure of improvement without the authority of Parliament. The difficulty of obtaining suitable accommodation has frequently been raised ; but this obstacle will be frequently surmounted if the attainment of the grand object is really desired. For instance, the ground behind Ponton Street, the Union Canal stone and manure wharfs, and a portion of Lochrin property, has frequently been referred to of late.* This situation has many advantages : it is in the vicinity of the cattle-market, has good drainage, abundance of water, and affords peculiar facilities for the removal of blood (now an article extensively used in manufactures) and refuse of every kind. There are also several other eligible pieces of ground, namely, two gardens further west and also a space between the Caledonian and Edinburgh and Glasgow Railways, nearly opposite the north gate of Dalry Cemetery; but the first is certainly the preferable. A mistake into which our civic authorities are apt to fall must be carefully avoided, namely, a belief that a comparatively small space will serve. Not a yard less than four acres should be thought of; for, connected with the slaughterhouses, there ought to be accommodation for selling skins, cleaning tripe, and melting tallow."

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* *See* Report on the Conditions prevailing in Scotland in Respect of the Provision of Public Slaughterhouses by Local Authorities, &c., by Frederick Dittmar, M.A., M.D., Medical Inspector to Local Government Board for Scotland.

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* An abattoir on the private booth system was subsequently erected on this site, and was in use until 1910, in which year a handsome new abattoir and markets were erected at Gorgie, just outside the city. AUTHORS.

Burghs with Public Abattoirs. According to Dittmar there are now "205 * burghs in Scotland, and 124 of these, or 60.48 per cent., have provided public slaughterhouses, but the proportion of the burghal population in Scotland which is served by public slaughterhouses is much higher than 60.48 per cent., as, with the exception of Aberdeen, nearly all the populous burghs have provided premises of this kind."

A Bay in the Byre of Edinburgh Cattle-markets

Intended for the up-putting of milk-stock for the most part. There are six of these bays, each capable of holding forty cattle; the byre is therefore fitted up for 240 animals; it is provided with hot and cold water and has an auction-ring at one end. Other portions of these markets are illustrated on page 368.

"Summarising the facts in regard to all slaughterhouses in Scotland, both public and private, there are, so far as the information in the Local Government Board's (Scot.) possession shows, 130 under public control, of which 129 are in burghal and nine in landward districts. Nearly 90 per cent. of the burghal population of Scotland, or about two and a half million people, are supplied with home-killed meat from the public slaughterhouses in burghs. In addition, a proportion of the population in landward districts is provided from these places, but it is not possible to estimate what proportion."

Since this report was written it is only fair to state that a splendid new abattoir has been constructed for the Fleshers' Incorporation at

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* Report.

Typical Exterior of Private Slaughterhouse

Aberdeen, and a similar institution forms part of a large collection of buildings erected by the Corporation of the City of Edinburgh for the accommodation of the various markets, also for a public abattoir, and, possibly, a dead-meat market. These buildings are situated at Gorgie, just outside the city.*

PRIVATE SLAUGHTERHOUSES

The private slaughterhouse in the United Kingdom is generally attached to the meat-purveyors' premises. There is no general application of any one design to these, their situation being regulated entirely by convenience of surroundings; and as the private slaughterhouse system came into existence at a time when hygienic requirements in connection with such places were not appreciated, it is not to be wondered at that there are many in existence which are of a very inferior character.

Exterior of Private Slaughterhouse

The open door on the right is the door of the slaughterhouse; the closed door on the left is the door of a water-closet.

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*See illustrations, pp. 368, 371.

Exterior of Private Slaughterhouse situated in a Court

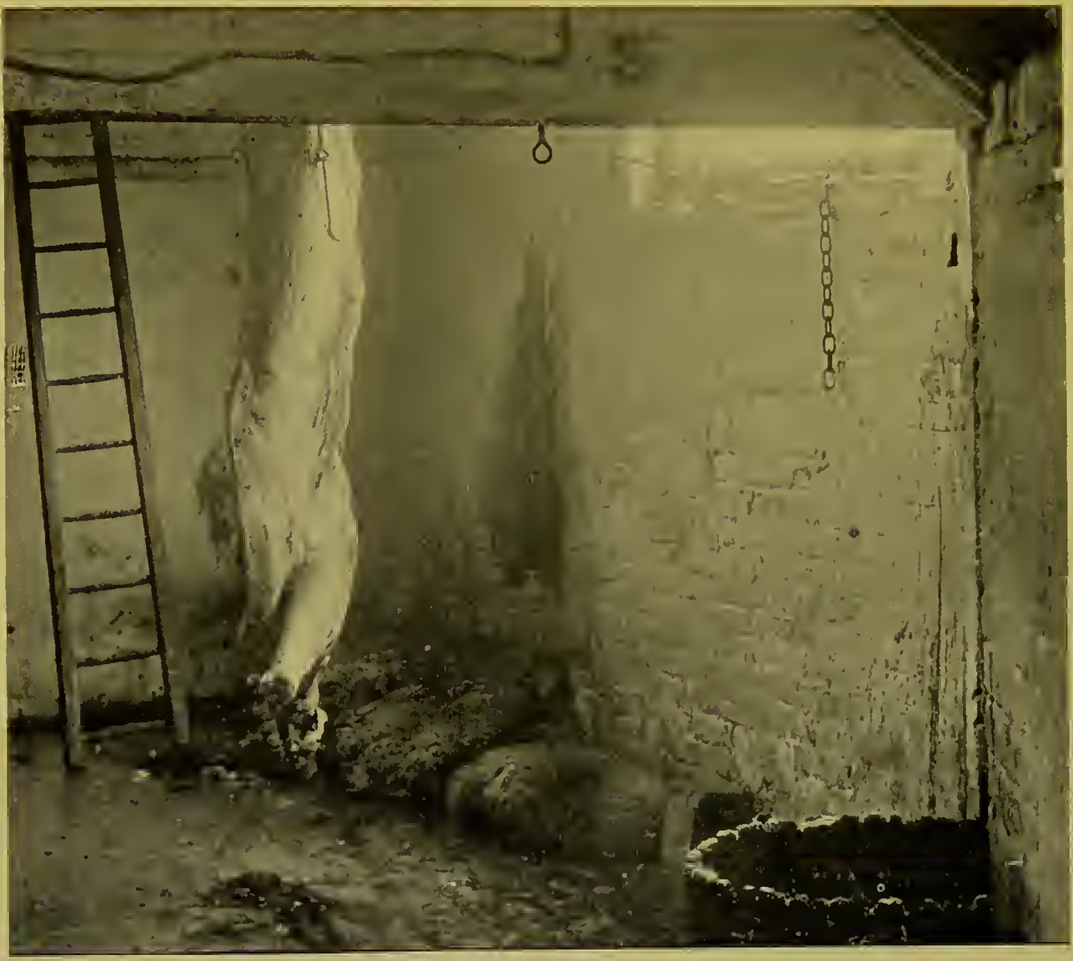
The double doors on the right are the doors of the slaughterhouse; the door on the left is the door of the fasting-pen.

In London itself there are 294 licensed private slaughterhouses, and while it may be said that the majority of these are conducted in a highly efficient manner, the fact that they are of necessity widely distributed militates against their being properly inspected by duly qualified sanitary inspectors. Hence, there have been many proposals to do away with these private slaughterhouses altogether and provide public abattoirs in their place. Naturally enough, the owners of these private slaughterhouses are averse to any change in the present conditions, as they consider that it is better to avoid the excessive handling of meat which is involved in the use of public abattoirs. It is also maintained that as the slaughtering of the animals and the handling of the carcases is under the supervision and control of the meat-purveyor himself, it is to his interests to see that everything is conducted in a properly hygienic manner.

There are many well-

Private Slaughterhouse

Primitive arrangements for scalding pigs.



Interior of Private Slaughterhouse

The surface of the walls should be covered with hard, smooth, impervious material. Here they are simply brick walls lime-washed.

disposed people whose opinion with regard to the private slaughterhouse is based upon the fear that in such establishments there can be no check upon cruelty and inhumanity in the treatment of the animals. There are, however, very few proofs that such inhumanity exists, at least to any great extent, and whatever quality there may be of that kind in some of the men who slaughter animals is hardly likely to be checked in a public institution.

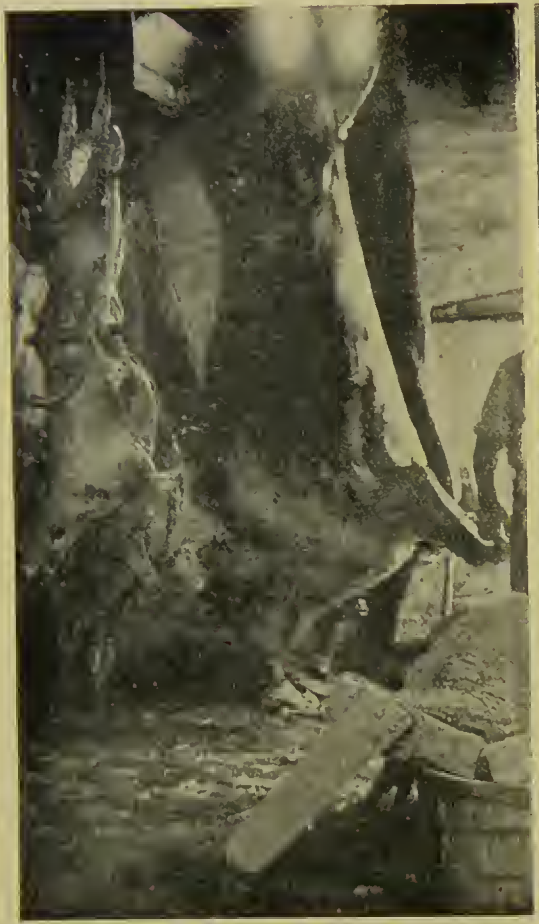
Objections to the Private Slaughterhouse. More serious objections to urban private slaughterhouses lie in the fact that they are generally situated in the densest thoroughfares, and in that way are likely to become a nuisance, not only because of the bringing of the live animals to such places, but on account of the sights and sounds associated with the business, which frequently lead to serious depreciation of surrounding property. In many cases the operations of slaughtering can be seen from neighbouring private houses.

The chief drawback, however, is the absence of adequate control. The right of entry for inspection to private slaughterhouses rests entirely with the medical officer of health and the sanitary inspector of the district, and it is quite obvious that unless a very large staff is available, control by such officers is bound to be of a very inadequate nature, and principally for this reason there is a strong feeling that it is in the interests of the community that the private establishments should be done away with altogether, and no doubt this will happen in a few years' time, and the public abattoir will then become universal. So long, however, as the private abattoir is allowed to exist, it is only right to say that there are many which are constructed so as to answer all the requirements of hygiene, and are conducted in such a way as to leave nothing to be desired. The illustrations in this chapter show conclusively what are the differences which exist between the unhygienic private slaughterhouse and one which is built on modern lines. The absence of ventilation in congested premises is apt to set up an offensive atmosphere which is likely to be injurious to the meat itself, and in that way become a positive danger to the community; for it is an unfortunate fact that the dangers which may arise in connection with meat are not appreciated by the average meat-purveyor. This is not his own fault, inasmuch as it is left to chance whether he should become educated in his business or not. There are no facilities for the technical education of the meat-purveyor in the United Kingdom, and the community therefore has to suffer through the want of knowledge which exists amongst these men.

The Necessary Equipment. The up-to-date private abattoir should be constructed so as to give plenty of ventilation; the floors

INTERIOR OF PRIVATE SLAUGHTERHOUSE

The flooring of a slaughterhouse should be of impervious material, with no crevices to harbour dirt.



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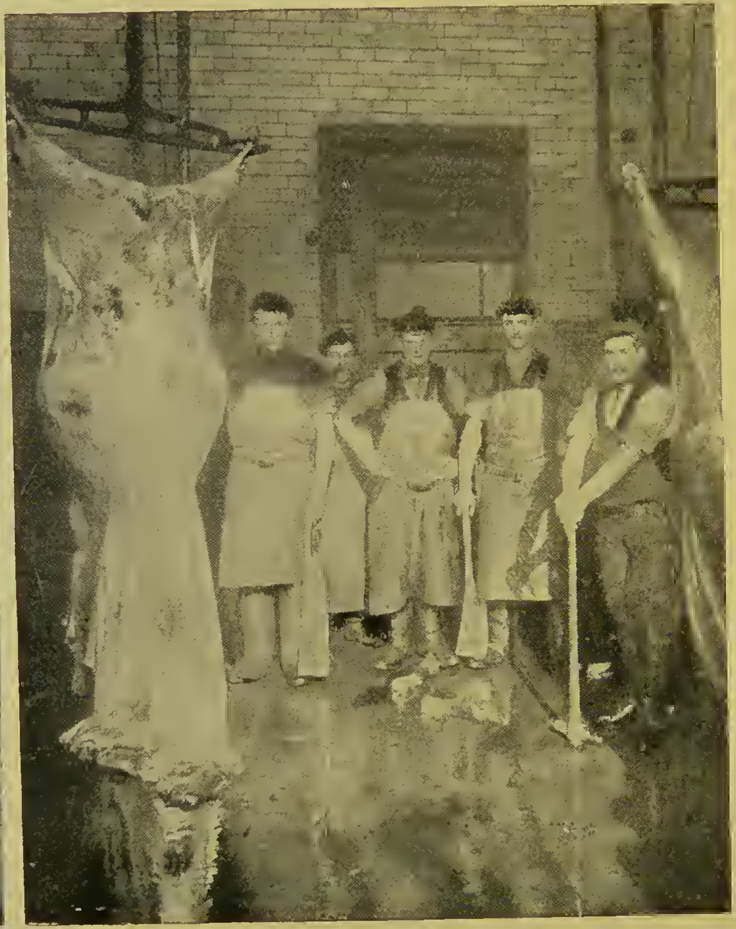

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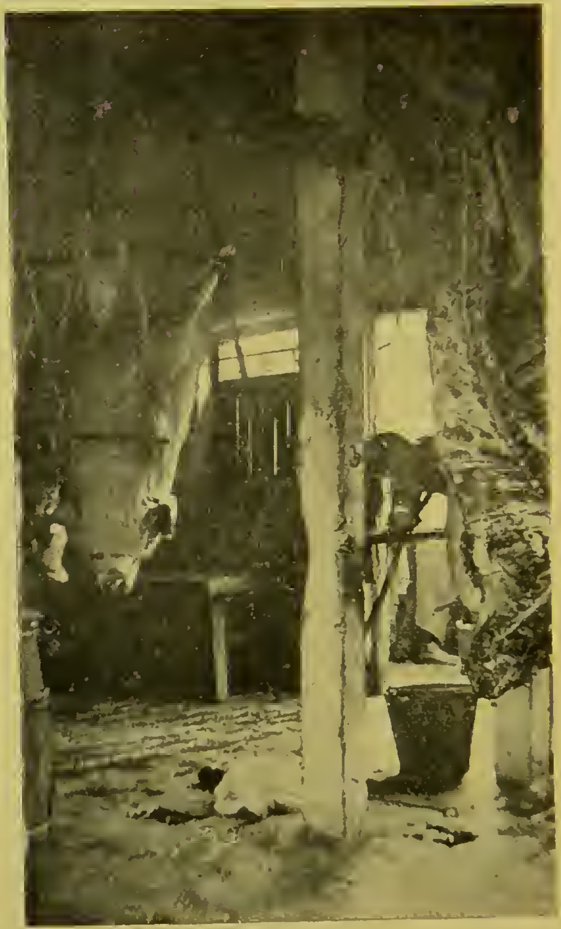
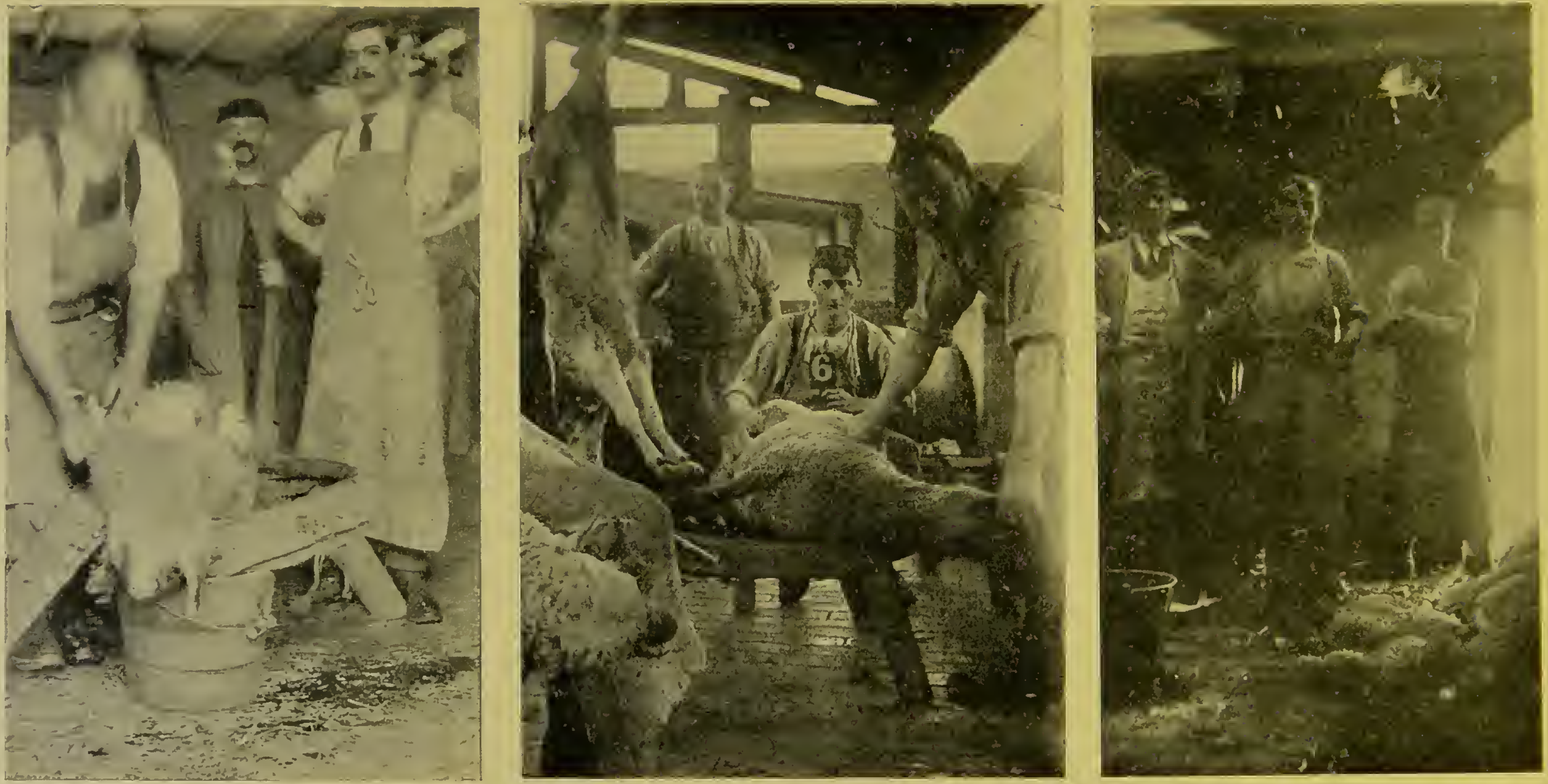


III

Antiquated Methods of Killing and Handling Cattle in Private Slaughterhouses

The timbers in the private slaughterhouse shown in the first picture are rotten, the flooring is bad and is below the level of the roadway outside; the middle picture gives a view of a cattle-slaughtering booth at Glasgow and shows the old-fashioned way of killing animals, while, as illustrated in the third picture, it not infrequently happens that in private slaughterhouses the meat is allowed to cool down in the slaughterhouse itself.



I

II

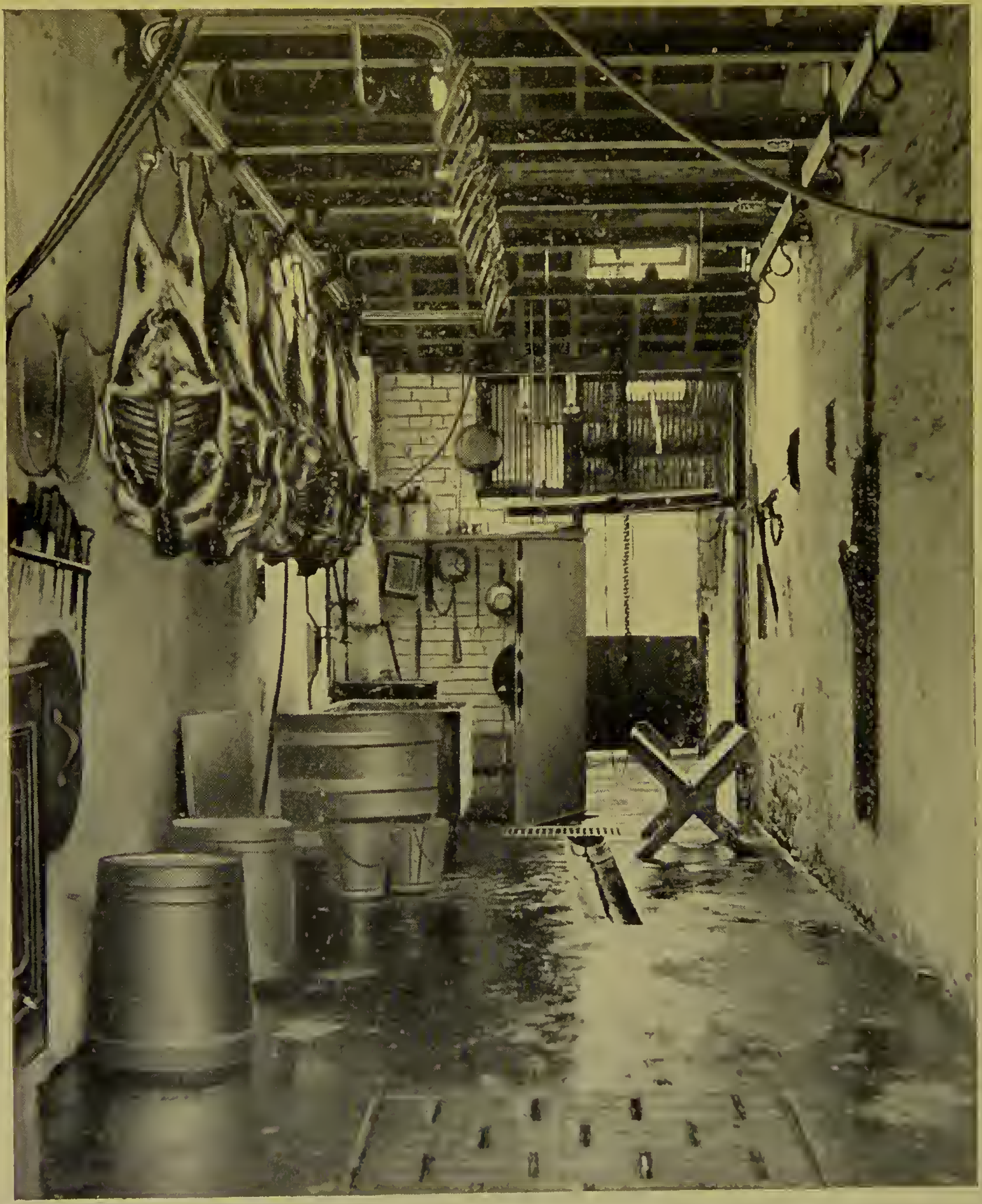
III

Private Slaughterhouses: Some of their Objectionable Characteristics Illustrated

An objectionable feature of the private slaughterhouse is that the operations can be viewed by children, who are often to be seen standing in the doorways. In the second picture the ordinary methods in Leeds' old shambles are strikingly shown. The sheep are killed with the knife without being stunned, and the calf (seen in illustration) is hung up alive, and slaughtered by having its throat cut, without being previously stunned. The dark interior and dilapidated roof shown in the third picture are worth noting.

and walls should be of impervious material, and, if possible, the walls should be lined with glazed bricks, which are so easily kept clean and are not absorbent. In this way the cleansing operations, which should be carried on every day, are easily performed.

With regard to the equipment, this must necessarily depend upon the number and class of animals which are handled. Iron track-bars, both for cattle and the smaller animals, ought to be provided, and the cattle bars should be suspended from overhead rafters, so as to give a clear height between the bar and the floor of at least 11 ft. Such a bar might easily be placed round two sides of a private abattoir, and



SMALL PRIVATE ABATTOIR SHOWING AN ORDINARY WELSH MEAT-PURVEYOR'S EQUIPMENT

This illustration provides an up-to-date example of a country meat-purveyor's establishment.

Interior View of Public Abattoir at Port Glasgow
Showing that the arrangements for handling are not quite up to date

the bars for the smaller animals might then be fitted to the other two sides at a height of 7 ft. from the floor.

Roller hooks for the cattle carcases are essential, but ordinary **S** hooks are quite good enough for the smaller animals. There will, of course, be the necessary accompaniment of the tools, which are required in the different operations, and which should consist of knives, choppers, slaughtering implements, saws, &c. These must be of the variety which commends itself to the actual operator.

The Abattoir of the Co-operative Society at Stockton

For the handling of residual products, a series of enamelled troughs are necessary, it being possible in every case to keep these much cleaner than would be the case if wood were used instead.

In small abattoirs it is necessary to have at least one or two boiling-pans so as to render fat when required, or which may be used for boiling tripes and similar articles.

The actual methods of slaughter are the same in all cases, whether conducted on the small or the large scale, and these will be described fully later on.

A very essential part of the equipment of a private abattoir is the hoist, which should be of such a design as to enable carcases to be lifted rapidly and without any jerking, and a desirable accessory also is an overhead weighing-scale which enables the carcases to be readily weighed when hanging on the bar; but with smaller animals it would be necessary to have a weighing-machine of smaller dimensions.

The private slaughterhouse is, as a rule, a building of one compartment, and has necessarily to serve many purposes, such as the handling of cattle, sheep, calves and pigs—it being generally impossible to have different departments for the various operations. In addition, the cleansing of the offal, the rendering of the fat, and the cooking of the tripes and cow-heels, are generally carried out in the same compartment. It is therefore obvious that there is great necessity for watchfulness in keeping such a place clean, and seeing that the drainage is always in perfect condition.

The model bylaws issued by the Local Government Board in 1877, which are still in force, are the only rules which govern slaughterhouses in the United Kingdom, and as they are of a unique character, they are given as an appendix to the present chapter.

PUBLIC ABATTOIRS

The construction of public abattoirs has, more especially during the last twenty-five years, called for much exercise of engineering skill, not only in the United Kingdom but in many European countries. There has arisen quite an industry, and a separate section of engineering, which has devoted itself to the equipment of public abattoirs. There is, therefore, no lack of available skill in connection with their construction, and we are able to reduce abattoir practice to certain broad principles.

The literature of the subject is considerable, the principal work being "Public Abattoirs and Cattle Markets," * by Dr. Schwarz, but there are a good many others of a subsidiary character.

It is generally recognised that a public abattoir should be associated with cattle-markets, so that the animals intended for slaughter can be conveniently taken from the market to the abattoir. This is convenient also from the point of view of inspection, as, should any animal which is

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* Edited by G. T. Harrap and Loudon M. Douglas, and published by The Ice and Cold Storage Publishing Co., Ltd., London.

offered for sale in the market be suspected of disease, it can easily be transferred, without loss of time, to the treatment of the abattoir officials; and to carry the matter a step further, it seems necessary that there should also be a dead-meat market alongside the abattoir. In this way the whole business can be centralised and placed under one control.

There is a difficulty in carrying out this centralised arrangement in places remote from large towns, but in Germany this has been solved by the creation of depots at certain points which serve to supply the surrounding districts.

In the various departments of the public abattoir, it should be recognised that there ought to be impervious flooring throughout, and that the first consideration should be a complete system of drainage. There should also be an abundant supply of water for cleansing purposes, and, having regard to the climate of the United Kingdom, it is desirable that the cattle-market should be covered.

The Internal Arrangements. The animals should be located in pens, according to their number, and a matter of this sort can best be arranged on the spot. The standing-room necessary for the various animals may be stated at 3 ft. wide by 8 ft. long for cattle, and for smaller animals, such as sheep, swine, and calves, a space of 18 in. by 5 ft. should, on the average, be allowed. With this data, it is possible to calculate the floor area required for any cattle-market, the approximate number of animals to be handled being previously ascertained.

Railings round the pens should invariably be constructed of iron, and should be 3 ft. 6 in. high, at least; gangways and passages should be, at least, 5 ft. wide.

In every cattle-market there ought also to be an observation pen, so that suspected animals may easily be isolated from the others, and it would be convenient to construct such a place quite near to the abattoir, so that immediate transference there can take place when necessary.

In any case, it will be seen that the cattle-market, when properly constructed, need not be a very expensive affair, and when it is considered how much depends upon the handling of an animal in the live state, it may be acknowledged that if an abattoir of elaborate design is necessary, it is also essential that the cattle-market should be constructed in such a way as to render it a comfortable place of business.

The sale-ring is a modification of the cattle-market, and is a convenient way of disposing of live-stock which are offered by cattle salesmen by auction, and in some parts of the country, such as Edinburgh, this method obtains almost exclusively and works very well.

It is possible also to give an equally concise figure in connection with the construction of abattoirs, and this has, by general acceptance, come to be recognised as a 10-ft. radius round each cattle-slaughtering ring. Such a radius works out to a span of 40 ft. as a convenient width for the abattoir building, if constructed on the open-hall system to be described presently.

How the Modern Abattoir is Constructed. There are two methods in use in the construction of modern abattoirs. These are the open-hall and the booth system.

The booth system, while lending itself to inspection by the abattoir authorities, permits of a certain amount of privacy in the operations. Each slaughterman can arrange to have a department for himself, and this can be so designed as to meet the requirements of both the small and large meat-purveyor. In a properly regulated abattoir there is no objection to the booth system, but there are many who consider that the divisions which the system involve are quite unnecessary, and interfere with the hygienic arrangements which should prevail.

The open-hall system, on the other hand, is pretty generally adopted, and consists of a large open building made up of the four walls, with the mechanical equipment only present, there being no divisions at all. The slaughtering-rings are generally placed as already indicated, at a distance apart which would give a radius to each ring of 10 ft., and the length and breadth of the building can therefore be calculated on this basis so as to suit the number of animals to be handled.

In some of the Continental abattoirs the large open hall for the slaughter of cattle is a distinct building from the smaller halls utilised for the handling of sheep, calves, and pigs, but in the United Kingdom there does not seem to be any inclination to multiply buildings in this way. The average cost of the German abattoirs as compared with such institutions in the United Kingdom, is very much greater, as the point of view is entirely different. In Germany the abattoir is regarded as an institution which must exist for the benefit of the community, just in the same way as the drainage of a town is a necessity.

In the United Kingdom, it is customary to regard abattoirs from the point of view of profit or loss.

Do Public Abattoirs Pay? Whatever may be thought of our standard of criticism, there appears to be great difficulty in ascertaining what the figures really are, at least in so far as the abattoirs in the United Kingdom are concerned. There is no law which compels returns from these places to be registered at the Local Government Board, or with any other central authority. Consequently, any one who wishes to arrive at intelligent data on the subject, has to rely entirely upon the courtesy of municipal officers, and it is regrettable that many of such officers do not see their way to assist in the compilation of accurate Tables in connection with this matter. The Table, however, which we are enabled to give fairly well establishes the fact that the general average of abattoirs in the United Kingdom do not pay their way, and it may be said that the community, except as ratepayers, is benefited to the extent of the loss. It does not seem possible to come to any other conclusion in the face of the data we have collected, and should any general demand for abattoirs come into existence, it must be recognised that it can only be done on the basis of the requirements of public health and regardless of the monetary cost to the ratepayer.

Lairage for Live-stock belonging to the Middlesbrough Co-operative Society, and a Model of its Kind

Profits from a Private Abattoir. In pleasing contrast with some of the statements of profit shown in connection with public abattoirs, an instance may be given of the profits derived from a private abattoir, namely, that of the Co-operative Society, Middlesbrough, which has been under the charge of Mr. J. Hobson for many years. In this

Middlesbrough Co-operative Society's Abattoir private abattoir there is a complete plant for the utilisation of the by-products, consisting of bone-digesting and grinding apparatus, and blood-drying plant. There is also a completely equipped small goods and sausage factory. The abattoir is notable as being the most complete private institution of its kind in the United Kingdom.

The following statement for the years 1888 to 1908 speaks for itself :

Return of the Sales and Profits of the Middlesbrough Co-operative Society

1888 to 1889

Sales.	*Net Profit.*	*Gross Profit.*
£10,550	£353	£1137

Average profit per week, £6 8*s*. ; gross, £21 15*s*.

1898 to 1899

Sales.	*Net Profit.*	*Gross Profit.*
£25,108	£2038	£4259

Average profit per week, £39 4*s*. ; gross, £80.

1907 to 1908

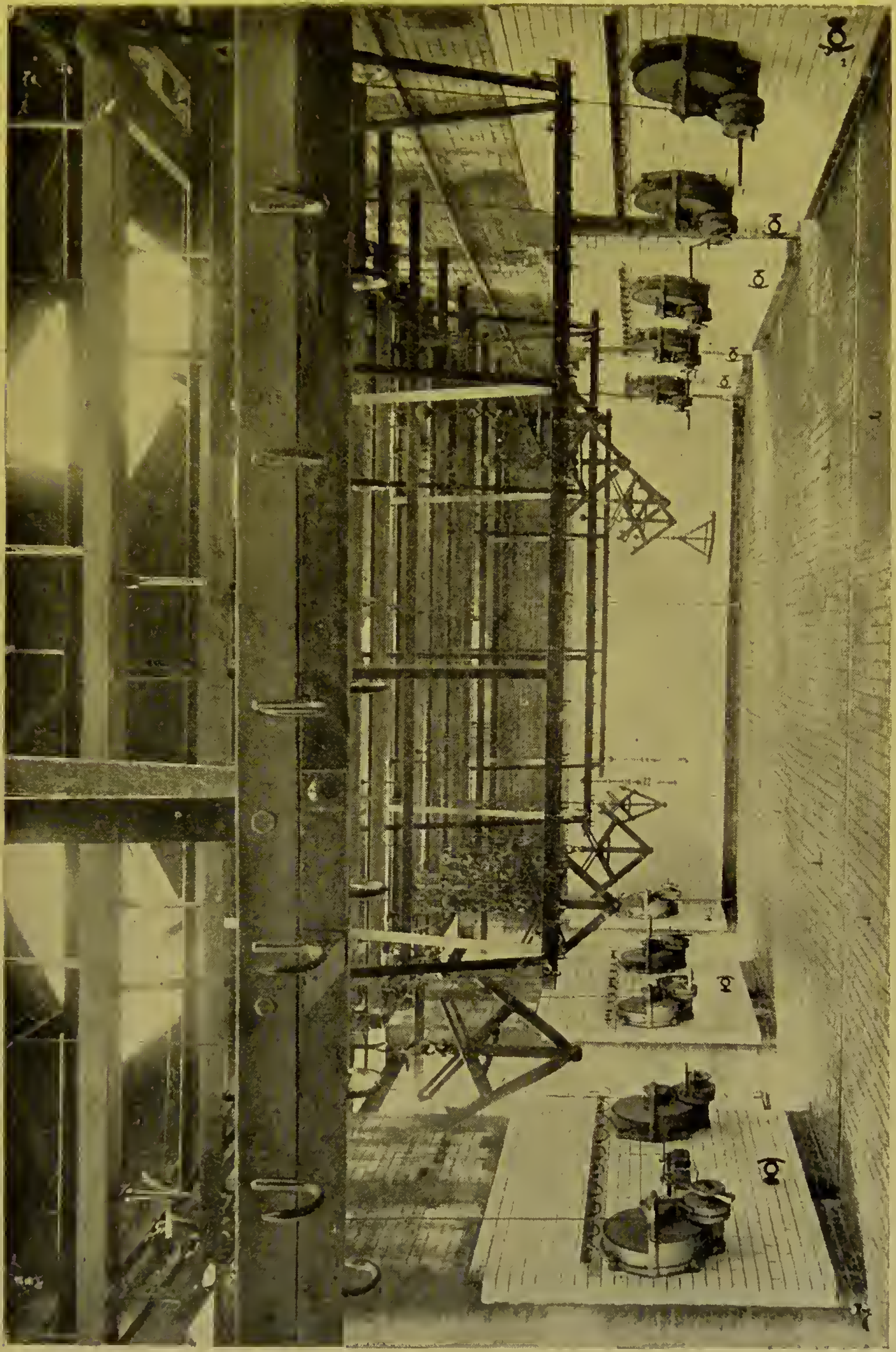
Sales.	*Net Profit.*	*Gross Profit.*
£50,252	£6360	£11,127

Average profit per week, £122 6*s*. ; gross, £214.

The Demand for Concentration. A public abattoir is a place of elaborate design, and the modern structure has been worked out, in nearly every place, through the co-operation and collaboration of the meat-purveyors with the architect and engineer. In this way there has come about a mutual understanding as to requirements, which has resulted in convenient places being erected, which not only give satisfaction to the meat-purveyors, but enable them to utilise their by-products to much better advantage than they could possibly do on the small scale.

The modern idea of the slaughtering of animals is that it should form one of the regulated industries, and this feeling is due principally to the desire that nothing but sound meat should be offered to consumers. It may be argued that sound meat can be produced in private slaughterhouses just as well as in public institutions, but this is bound to be wrong so long as it is recognised that the onus of judging as to whether the meat is sound or otherwise, ought not to rest with the meat-purveyor at all. If public officials are to have the responsibility, then it is only fair that the industry should be concentrated at certain centres. We are aware of the fact that all animals intended for the food-supply are liable to disease, and, as we have already pointed out, there has been no kind of attempt on the part of the meat industry to provide veterinary education for its members. The public, therefore, can only be protected by the appointment of qualified veterinary inspectors, specially detailed for this particular industry.

Essentials in a Modern Slaughterhouse. The public abattoir should, as far as possible, be removed from the busy thoroughfares, and should be readily accessible without the animals having to travel through the busy streets of the town or city.

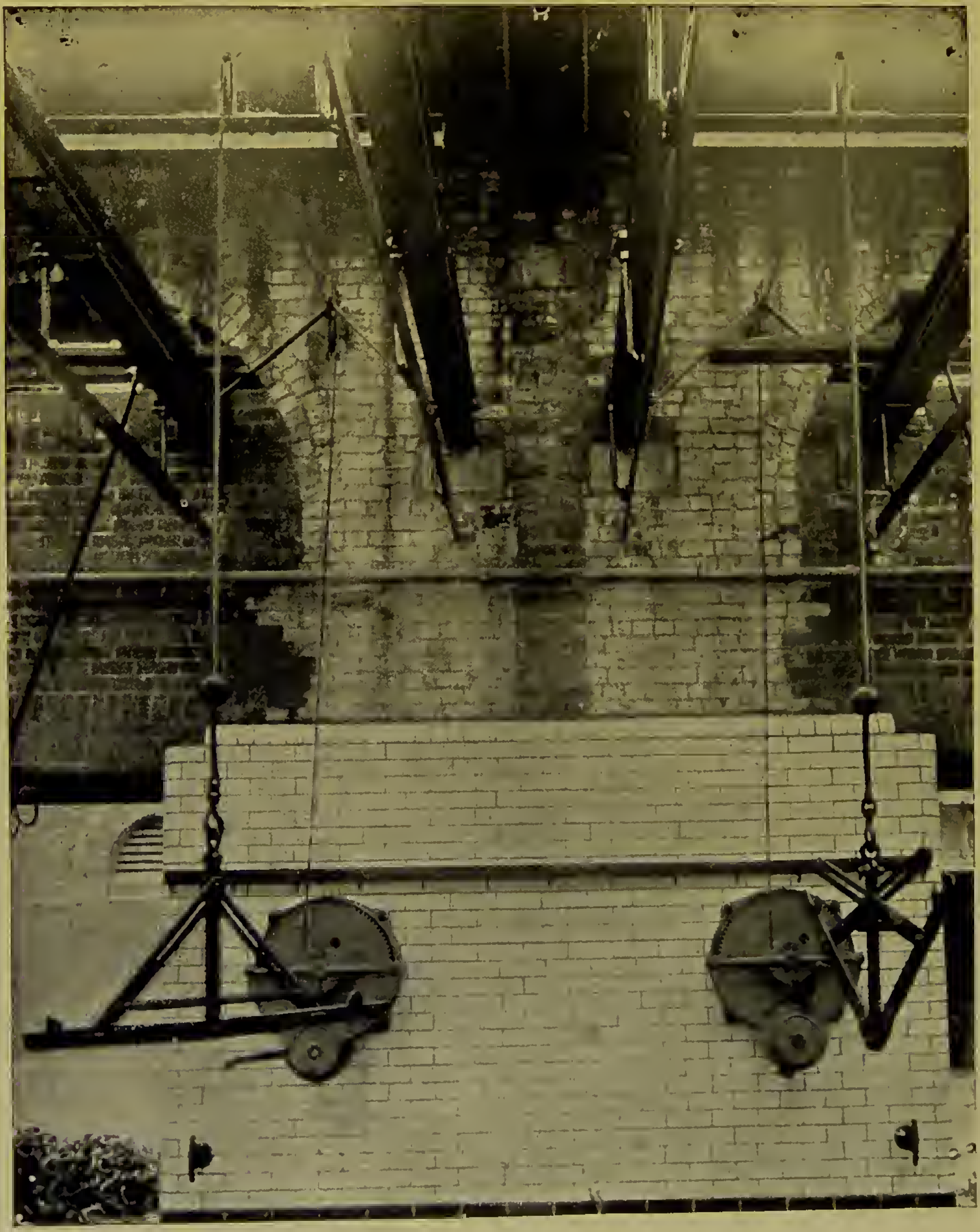


General View of the Interior of a Modern Abattoir Main Slaughtering-hall for Cattle and Sheep
Showing the arrangement of self-sustaining hoists, overhead-tracking and hoisting gear. The low bars are for hanging the carcases of sheep.

Where the buildings are on the one level, it will be found convenient to fix the height of the wall-plate at a minimum of sixteen feet, and the construction of the walls must depend upon local conditions. Brick walls, lined with white enamelled bricks, form a splendid structure, easily controlled and easily kept clean. Wood should, as far as possible, be avoided in the construction, although it is undesirable sometimes to provide anything except timber for roof principles. There should always be a complete system of open louvres on the ridge of the roof.

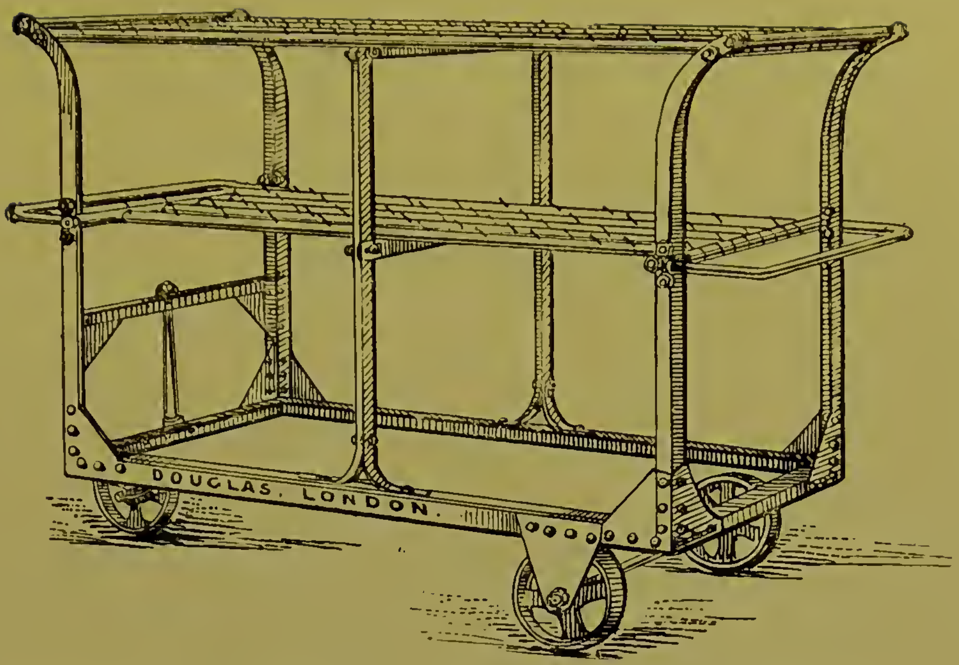
As has been said, the span of the ordinary open hall should be about forty feet, and this will enable two cattle to be handled at once in the width. The handling of the smaller animals is, of course, a matter of convenience, with the exception of swine, which should be slaughtered in a separate department.

The modern system is to utilise the abattoir for the slaughter of the animals, the inspection of the meat, the cleansing of the by-products,



Details of the Mechanical Fittings of an Abattoir

Showing the self-sustaining hoists and suspending steel ropes for carcases. One beef stang, or spreader, is shown extended and another in the collapsed state.


DOUGLAS. LONDON.

Pluck- and Offal-rack

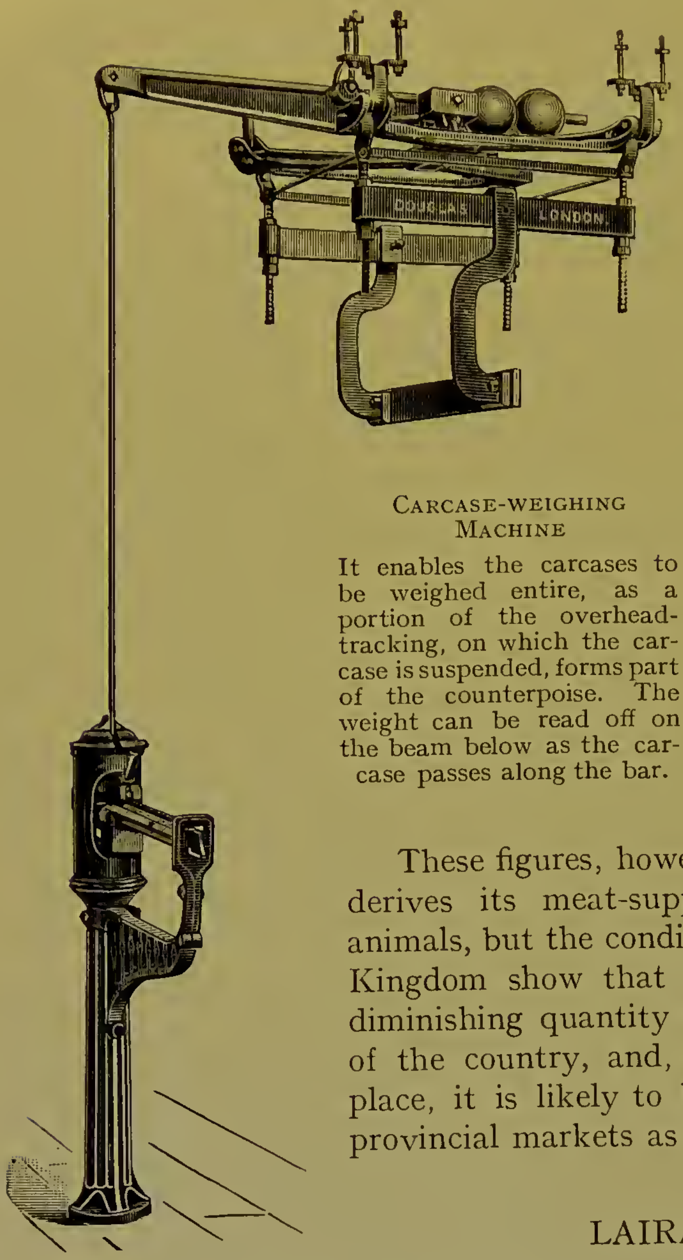
For suspending offal in abattoirs and conveniently running it from place to place.

and the utilisation of the blood and any carcases which may be condemned because of disease.

On such a basis the departments of a modern abattoir would be as follows :

- (1) Lairage.
- (2) Slaughtering-rooms or halls, subdivided into :
  - (*a*) Hall for cattle.
  - (*b*) Portion of same hall for sheep and calves.
  - (*c*) Hall for pigs.
  - (*d*) Hanging-house or cooling-chamber.
- (3) Cold chambers for maturing and storing meat.
- (4) Offal-room and tripe-house.
- (5) Meat inspector's room.
- (6) Room for condemned meat.
- (7) Destructor-room for utilising condemned meat.
- (8) Engine and boiler-house containing :
  - (*a*) Steam boiler.
  - (*b*) Steam engine.
  - (*c*) Refrigerating machine.
- (9) Manure depot.

These departments form an abattoir proper, and in a well-constructed establishment there would also be residences for the officials, porter's lodge and administrative block. There should also be a loading and unloading platform if the railway is adjacent, and for the convenience of the operatives, there should be a restaurant. If possible, the manager or chief inspector of the abattoir, should reside on or near the premises, so that everything that takes place will be under his control.



Carcase-weighing Machine

It enables the carcases to be weighed entire, as a portion of the overhead-tracking, on which the carcase is suspended, forms part of the counterpoise. The weight can be read off on the beam below as the carcase passes along the bar.

We have already given some general data from which the size of an abattoir can be determined, but this is a matter which must always be governed by local conditions. The population of the town or district for which the abattoir is to be provided is of prime consideration, and on this subject we have the authority of a German author,* who gives the following as the cubical capacity of an abattoir according to the inhabitants :

For towns of from 5000 to 7000 inhabitants, 4 cub. ft. to each inhabitant ; for towns of from 7000 to 10,000 inhabitants, 3½ cub. ft. to each inhabitant ; for towns of from 10,000 to 50,000 inhabitants, 3 cub. ft. to each inhabitant.

These figures, however, apply to a country which derives its meat-supply mostly from home-killed animals, but the conditions which exist in the United Kingdom show that the home supply is a largely diminishing quantity in the principal city markets of the country, and, unless some alteration takes place, it is likely to be a declining quantity in the provincial markets as well.

LAIRAGE

The lairage for animals takes the place of the fasting-pens in the private slaughterhouse, and it is convenient to have them situated alongside the abattoir, but generally it should be recognised that the buildings should be so constructed that the lairage will not command a view of the slaughtering-halls, and that the live animals will not be able to see others being slaughtered. This is generally looked upon as being, not only inhuman, but animals which are slaughtered in a state of fear usually produce meat of an inferior character and with a tendency to rapid decomposition.

SLAUGHTERING-HALLS

As we have seen, the hall for cattle can be utilised for sheep and calves, and the principal requirement is to have a lofty hall, plenty of

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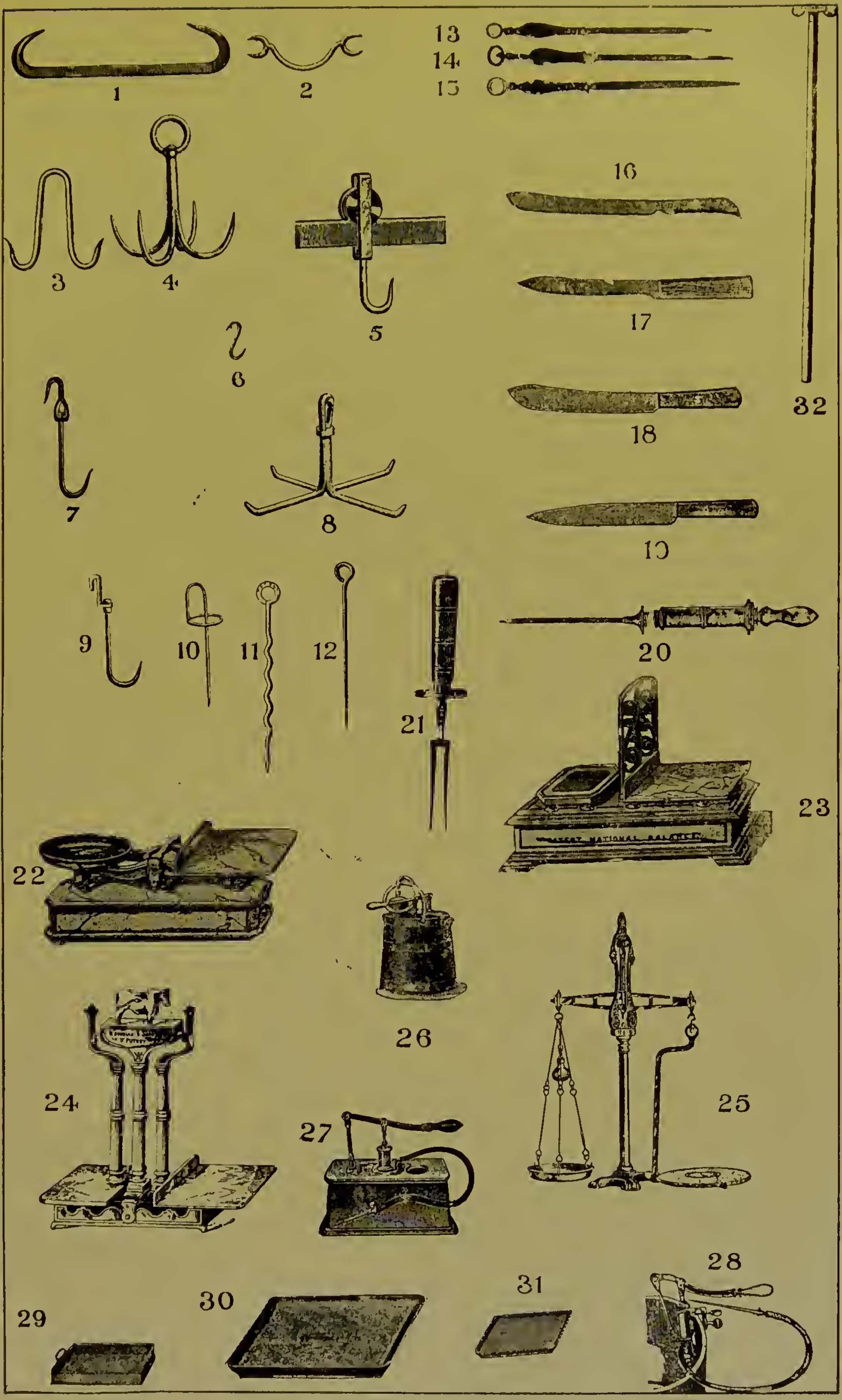
* Oesthoff.



Tools and Appliances used by the Meat-purveyor

1, Chine hook; 2, Breast hook; 3, Tinned close gambrels; 4, Tinned pluck hooks; 5, Roller hook on bar; 6, Small S hook; 7, Swivel hook; 8, Sausage hook; 9, Swivel hook for rectangular bar; 10, Wire skewers for holding briskets in position; 11, Galvanised crinculated skewer for rounds of beef; 12, Polished steel skewers for holding briskets on carving-block; 13–15, Different kinds of steels; 16, Steak knife; 17, Boning-knife; 18, Shop knife; 19, Sticking-knife; 20, Pickling-syringe; 21, Fork for handling cooked meats; 22, Flat type of counter balance; 23, Enclosed type of counter balance with ornamental division; 24, London meat-purveyor's counter scale; 25, Overhead beam type of counter scales; 26, Pickling-pump, barrel type; 27, Pickling-pump, iron box type; 28, Pickle pump for fastening on to the edge of a tub or pickling-tank; 29, Cooked meat tray; 30, Long window show dish in enamelled ware; 31, Small window show dish; 32, Long arm for reaching down small joints from high bars.

light and perfect mechanical arrangements. First amongst these is the hoist, which should have two speeds, both under complete control. There are various kinds of abattoir hoists, but those which hold the load automatically at any point are the best, and a simple mechanism permits of the carcases being lowered as desired. Hoists are not required for either calves or sheep, as these are handled by being suspended with gambrels to the bars, which should be about seven feet from the ground.

The handling of pigs is usually performed in the following manner: They are brought into the catching-pen, where they are hoisted one by one by one of the hind legs to a circular overhead track-bar of 1¾ in. round iron, 11 ft. from the floor-level. The animal is suspended by means of a double-headed hook to this track-bar, and while in this position, head downwards, is slaughtered by the insertion of a knife in the direction of the heart. The operation is quickly done, and the carcase is pushed along the bar, which is greased, and the blood immediately flows out; the carcase is then thrown on to a dumping-table, and the leg chain removed, after which it is rolled into a scalding tank, where water is available at a temperature of from 140 to 180 degrees Fahr. The carcase is rolled about in this water until the hair is easily removed, and is then tilted by means of a cradle actuated by a lever handle, to a scuttling-table, where it is scraped and all the hair removed. The carcase is then suspended, head downwards, on a track-bar 7 ft. 2 in. from the ground, and while in this position the viscera and offal are removed. The carcase is then spread open by means of a gambrel, and is allowed to cool, after which it may be cut into sections or sent away whole to be dealt with in the meat-purveyor's or curer's establishment. In bacon factories, however, the general practice is to handle the pigs in the factory itself, and not in the public abattoir.*

In the north of Ireland there is an old-established custom in existence whereby the farmers slaughter the pigs on the farms and cart the carcases to the pig markets in their vicinity, where they are weighed and sold at the public weighing-machines. This is a system which has many disadvantages, and is the cause of an enormous amount of taint in the bacon and hams produced in the north of Ireland.

The Cooling-chamber is a very essential part of the modern abattoir, and as soon as the carcases have been cleansed they should be pushed along the track-bars into a separate cooling-chamber where the excess of animal heat may be allowed to escape. The tracking in such a chamber should be on the same level as the tracking in the abattoir, both for the cattle and also for the smaller animals. Usually, the heat from the carcase under ordinary conditions should dissipate in about six hours, and the temperature may then be reduced to about 70 degrees Fahr.; during cold weather this temperature will be further reduced if the carcases are allowed to hang overnight, more especially if there is a current of air in the cooling-chamber, and then it is a question for the meat-purveyor to decide whether he will mature them in the chill room or handle them as they are. Much depends upon the proper maturing of the meat, and

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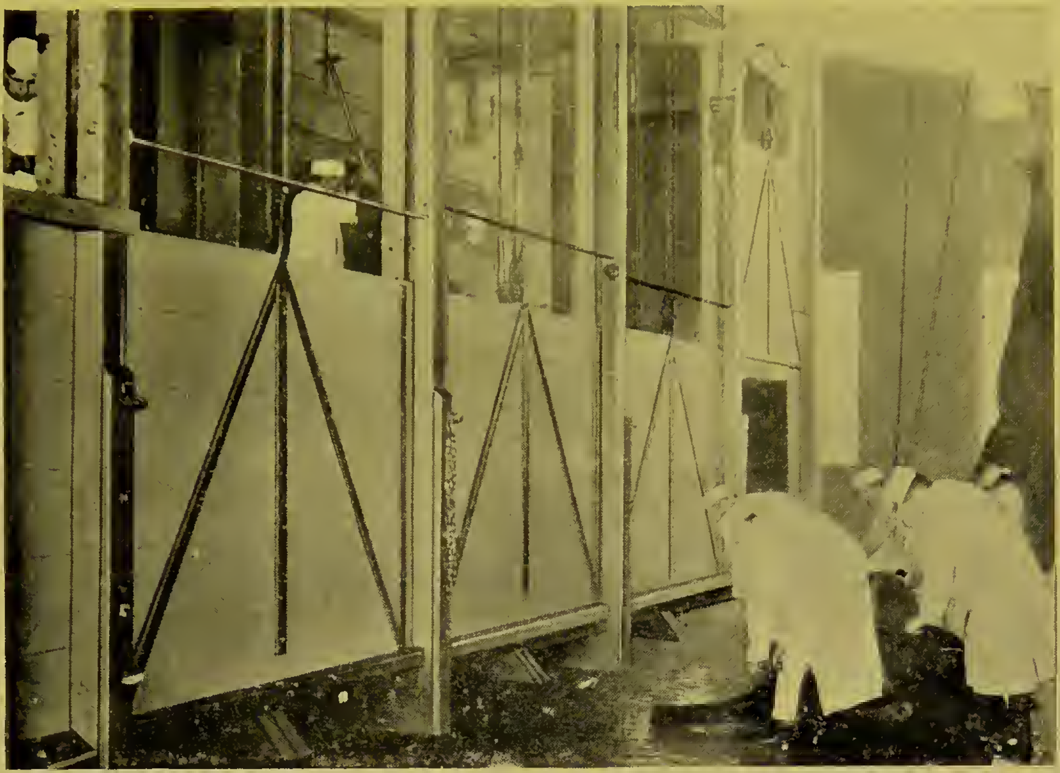
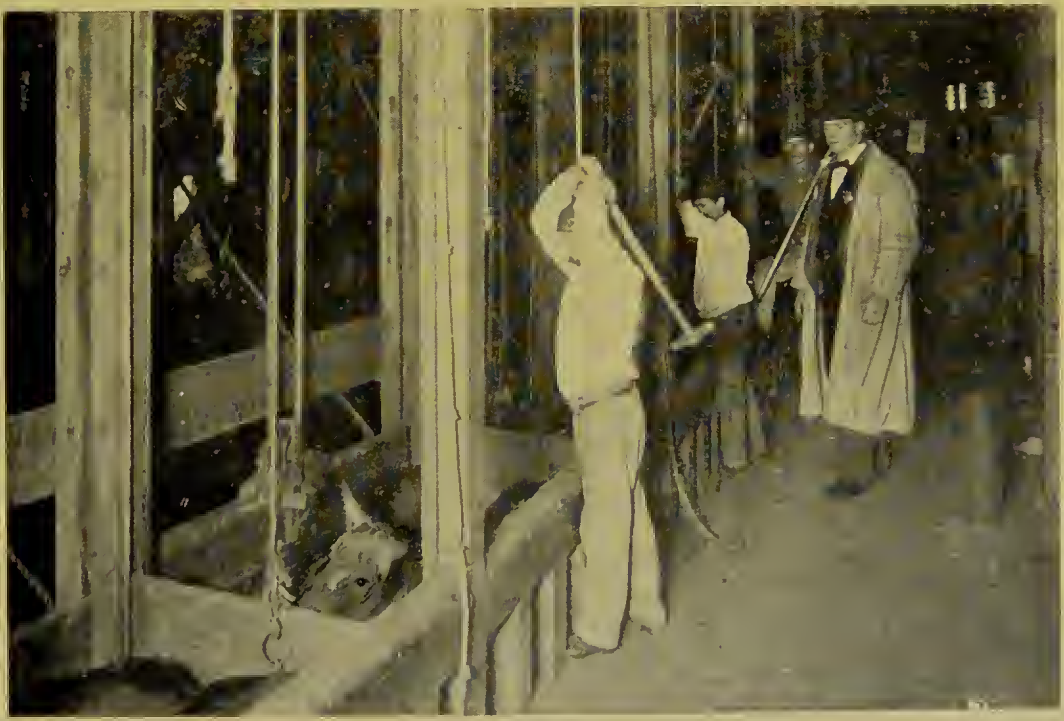
* See *Bacon Curing* in Vol. I.



Interior of American Abattoir

Showing the knocking-down pens in which all cattle are stunned before being bled. As soon as they fall in the knocking-down pen they are rolled out on to the adjoining floor and are at once hoisted to a rail on which they are bled.



Slaughtering Cattle in an American Abattoir

The illustration shows the upper side of the knocking-down pen.

the process itself is due to a slight decomposition which supervenes after the stiffening or *rigor mortis* has begun to disappear. At this point the liability to decomposition is considerable, and it is therefore desirable that the cooling-house of the modern abattoir should be of a hygienic character, and free from any odours which will be likely to be taken up by the meat.

Cold Chambers. The importance of chilling meat to a temperature considerably below that of the atmosphere has been generally recognised in late years, and the process is fully described in the chapter on Refrigeration.

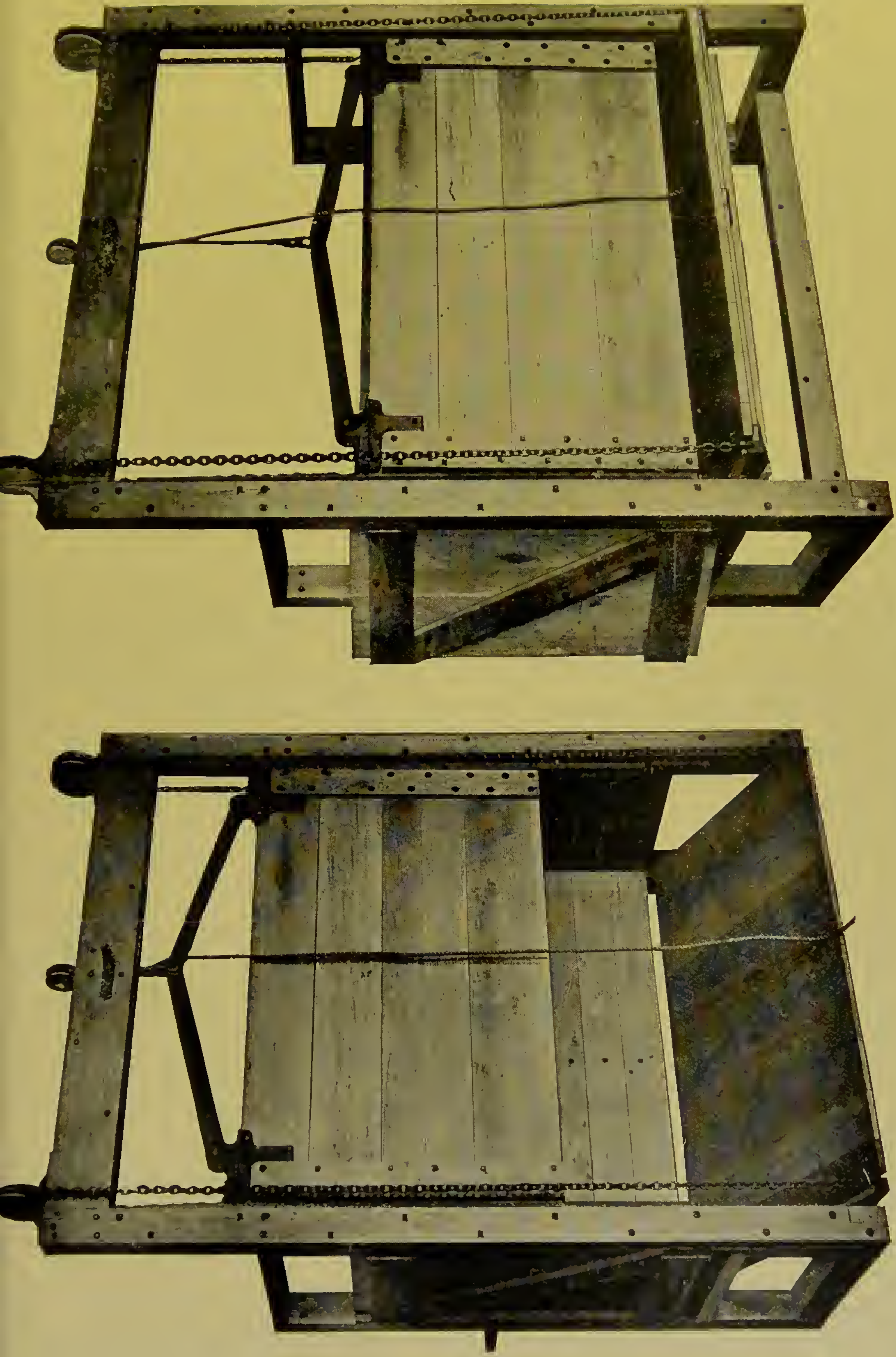
Offal-room and Tripe-house. A very considerable industry exists in connection with the manufacture of tripe and the cleansing of the intestines of animals used for food, and a large apartment is necessary for the handling of these various commodities.

Tripe consists of the stomachs of cattle, and a series of troughs are necessary for its proper cleansing. The stomachs are first of all split and roughly cleansed, and are then thrown into water so as to soften the mucous membrane. After this they are either brushed by hand or machinery so as to remove all sediment, and they are bleached by means of either soda or lime, and afterwards are well washed. Alum is frequently used as a bleaching agent, but it is inclined to make the tissues rather stringy. Hot water may also be used with advantage to assist in the bleaching and softening of the tissue, the desire being to get as white a product as possible. Before offering the tripe for sale, however, it should be immersed in cold water to which a small quantity (say, 10 per cent.) of bisulphite of lime solution has been added, and this will prevent any rapid decomposition which might otherwise take place.

The Dressing of Casings. The cleaning and dressing of the intestines, which, under the name of "casings" or "skins," are used in sausage-making is a business which is generally carried on separately, and, except in small abattoirs, does not form part of the work of the offal department. In many cases the cleaning is done by hand, the casings being turned outside in, so as to expose the inner membrane, which is removed by means of a blunt knife. The casings are first of all washed in cold water, and then transferred on the following day to fresh water, after which they are removed and are packed in salt for future use.

Meat Inspector's Room. The meat inspector's room has become an essential feature of a modern abattoir, as it is from this department that the hygienic character of the meat is controlled. There are no special fittings necessary in such a room, but it should be situated at a convenient place where the inspector may be found quickly, whenever he is wanted.

Room for Condemned Meat. Contiguous to the inspector's room and adjacent to the meat-destructor room, there should be an apartment set aside for keeping separate any meat which may be condemned. There is no need for any special equipment in such a room beyond a wall-hoist and a high track-bar, at least 11 ft. from the ground, for complete carcases, and some low bars along the wall 7 ft. from the ground. The walls

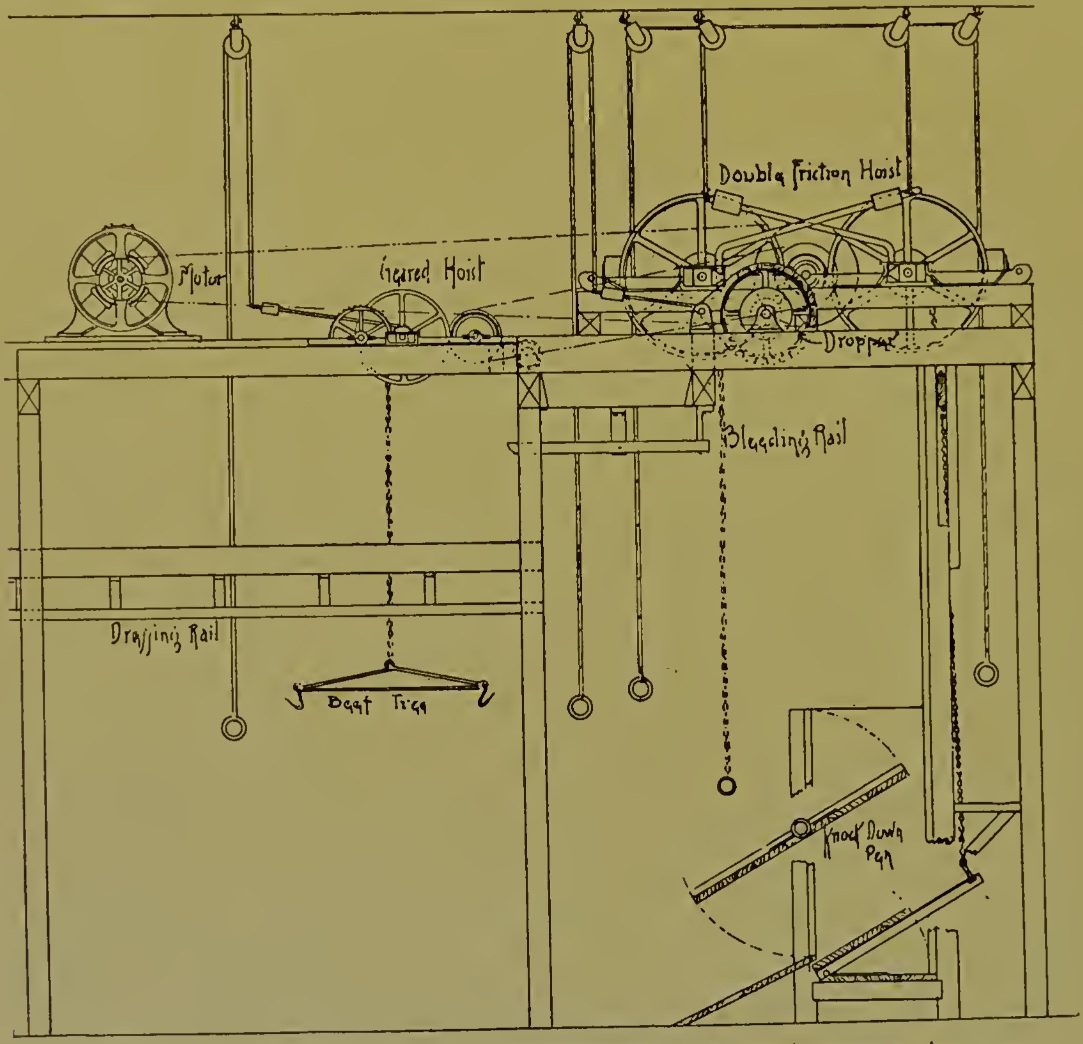


AMERICAN SLAUGHTERING-PENS

The first illustration shows the floor canted up and door raised so as to permit of the carcase falling out. The animal is stunned by a blow on the forehead, and as it falls, the floor of the pen is canted up as shown, and the carcase falls out.

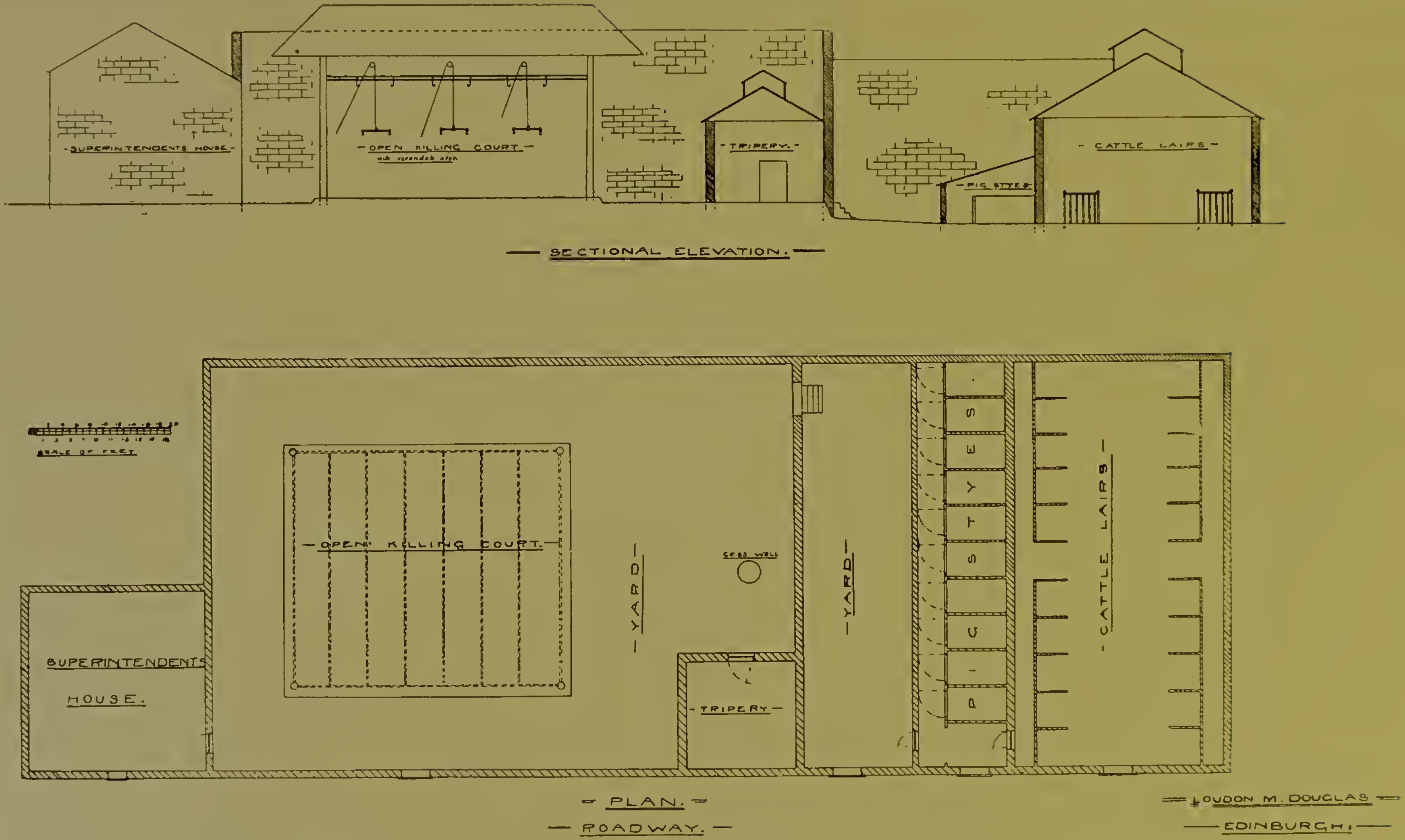
and floor should be constructed of impervious material which can easily be cleansed. The doors entering into such an apartment should be constructed either of sparred woodwork or latticed ironwork, so that a plentiful current of air will be available. The condemned meat room should be under the control of the chief veterinary inspector, who should keep a very close watch over its contents.

Destructor-room. One of the most important departments in connection with a modern abattoir is the destructor-room, and it should be equipped with a modern apparatus for the conversion of diseased and condemned meat into an impalpable powder. There are several plants designed for this particular purpose, one of them being that of Baron Podewils. The first consideration in connection with the handling of condemned meat is the conversion of this article into a sterile powder, which may still be of economic value, while at the same time it may be free from any danger of spreading disease. The Podewils apparatus, which certainly accomplishes this, consists essentially of a revolving drum which is actuated by a steam-engine. The drums are made in



General Arrangements of Slaughtering-track in an American Abattoir

Showing the knocking-down pen, double-friction hoist for elevating the carcase, bleeding rail, beef-tree, dressing-rail and electric motor for hoist.



ARRANGEMENT OF A SPANISH ABATTOIR.

Showing the open killing court and the accessory departments. In Spain the slaughtering is done mostly in open places.

various sizes according to the requirements of the abattoir (*see* chapter on By-products).

Engine- and Boiler-house. In a modern abattoir it is recognised that there should be plenty of steam, and it is therefore desirable to provide a large margin of boiler power. It very frequently happens that one boiler has to be laid off for cleaning and repairs, and in view of this contingency it would seem to be desirable that a duplicate should be put in, and thus the boiler-house would contain two boilers, each of which would be suited to the dimensions of the abattoir.

The Steam-supply in an abattoir serves several purposes. It can be used for the steam-engine which is necessary to drive the machinery in the tripe-house: the engine attached to the refrigerating machine, or the engine attached to the destructor. It may also be used to supply hot water for the various departments of the abattoir. This latter is quite an innovation in modern times, and most recent abattoirs have found it a great convenience to have a constant supply of hot water available throughout the whole premises.

The manure depôt may be conveniently situated near the tripe-house, and the contents of the stomachs and other residual matter should be deposited at this particular point. The manure should never be allowed to accumulate, and by far the best arrangement is to have a sunk manure chamber in which iron manure-waggons may be placed. The manure can be thrown into these waggons through port-holes in the floor above. As soon as these waggons are full they may then be carted away, and in this way the abattoir be kept sweet and clean. Under no circumstances should manure be allowed to accumulate to any great bulk, as it serves only for the attraction of flies, and such in the presence of hanging meat, are not only highly objectionable but dangerous.

Details of the fittings of a modern abattoir may be better understood from the illustrations accompanying the text than from any description, and with this end in view many illustrations are given which serve to show the various appliances that are generally adopted.

THE FREIBANK

There is one department of an abattoir which has never found very much favour outside of Germany, but which is certainly a great acquisition. This department is termed in Germany " the freibank " ; there is no appropriate equivalent in English. Its principal use is to provide the means of selling meat which may be derived from a partially diseased animal which has been condemned. It is generally accepted that the toxic effects which might be present in the meat derived from a partially diseased carcase is very small in the parts of the carcase farthest removed from the diseased portion and, even supposing that some toxin were present, it is likely that the toxic effects will be modified by proper cooking so as to destroy them altogether. Hence, in connection with the Freibank there is an apparatus provided, the principle of which is, the total sterilisation of the meat (*see* chapter on By-products).

In connection with the use of the Freibank, it is of interest to refer here to a Report on Meat Inspection in Germany as compared with Great Britain, by a Deputation from the City of Glasgow in 1908, and which has been published by the Glasgow United Fleshers' Society.

The following is a summary of the opinions of the Deputation on

The Freibank and Its Uses. "Briefly stated, the Freibank (peculiar to Germany) is really a municipal shop within the abattoir to which meat not good enough to be sold in the ordinary course of business, and too good to be condemned as unfit for food, is sent for special treatment and sale by the authorities for behoof of the owners thereof. In close proximity is a room where, if deemed necessary, the meat may be parboiled or sterilised before being offered for sale to the public. Before leaving Glasgow we had been told, and fully understood, that all meat sent to the Freibank was sold only after it had been subjected to the process of sterilisation. What actually came under our own immediate notice in Berlin and Frankfort-on-the-Main was, however, sufficient to disabuse our minds on that particular point. In those two cities we were fortunate enough to be within the abattoir at the time when business was in full operation at the respective Freibanks. By the kindness and courtesy of the authorities we had the privilege of viewing the proceedings in each case, and, much to our surprise, we noticed that the bulk of the meat was being sold in its raw and uncooked state, a small proportion of it after it had been parboiled, while none of it whatever had been subjected to the more drastic treatment of sterilisation. As a matter of fact, sterilisation is rarely resorted to. In both cities respectable-looking people crowded those places, and made their purchases in a quiet and methodical manner. Each customer, in approaching the counter, behind which stood the salesman, made his or her demand known, had it attended to, paid the money and walked out, to all appearance perfectly pleased with the morning's marketing. No one customer is, however, at liberty to buy more than 6 lb. of meat at a time.

"As already indicated, the Freibank is run entirely by the particular authority under whose jurisdiction it exists, and by whom the prices for each day are fixed. The meat is weighed in bulk to the salesmen, but some 3 or 4 per cent. is allowed for loss in cutting out, and, after deducting something like ¼*d.* per pound to pay working expenses, the balance of the amount drawn is paid over to the rightful owner. The prices charged while we stood by, were fairly high, and the meat that was sold in our presence was, comparatively speaking, dearer than first-class meat. And yet we were assured by those competent to speak, that the supply of meat at the Freibank was invariably quite inadequate to the demand—a state of matters that carries with it many lessons for those who care to read. Actual observation convinced us that not only the whole of the meat sold at the Freibank, but much that was stamped and passed for sale in ordinary shops, would have been totally condemned and rendered worthless as an article of food in Glasgow."

The following Tables are of interest as showing the total of carcases condemned in relation to the numbers of cattle and pigs slaughtered in various European cities.

City.	Cattle Slaughtered.	Affected with Tuberculosis.	Totally Condemned.	Percentage.
Berlin, 1906 . .	160,372	—	364	1 in 440
Munich, 1907 .	66,533	—	141	1 ,, 472
Hamburg, 1907 .	65,268	—	86	1 ,, 759
Breslau, 1907 .	26,257	—	66	1 ,, 398
Frankfort, 1906–7 .	35,380	—	80	1 ,, 442
Cologne, 1907. .	33,350	—	113	1 ,, 295
Offenbach, 1906 .	4,587	—	8	1 ,, 573
Aggregate of seven German Cities .	391,747	112,298 = 28.67%	858	1 ,, 456
Glasgow home cattle, 1906 . . .	43,895	8,766 = 19.97%	2,184	1 ,, 20

City.	Pigs Slaughtered.	Totally Condemned.	Percentage.
Berlin	1,018,693	425	1 in 2,397
Hamburg	379,782	612	1 ,, 620
Munich	266,246	192	1 ,, 1,386
Cologne	196,291	35	1 ,, 5,608
Frankfort . . .	150,451	17	1 ,, 8,850
Breslau	129,461	84	1 ,, 1,541
Offenbach . . .	15,076	1	1 ,, 15,076
Seven German cities . .	2,156,000	1,366	1 ,, 1,578
Glasgow *	45,456	197	1 ,, 231

How Blood is Treated. An essential product in an abattoir is the blood, and this may be applied to different uses :

(*a*) It may be converted into serum and dried blood.

(*b*) It may be made into fertiliser.

Besides these two principal uses, a portion of it is used for making black puddings, but this gives rise to a very infinitesimal demand in connection with a large abattoir, its principal outlet being in the manufacture of serum and dried blood.

The manufacture of serum was, at one time, a very profitable industry, but owing to substitutes having been provided, it is questionable if it is such at the present day.

The process is a very simple one, and consists in collecting the fresh blood in flat tinned-iron rectangular dishes, which are so constructed that they may be set at an angle on the top of receivers constructed of the same material, and tilted up at one end so that the serum, which is

* Glasgow, additional, 2034 heads of swine and 2820 heads and tongues of cattle.

separated out while the blood settles, may be drained off into the receivers beneath. The serum is then dried on flat trays in the drying-room at 180 degrees Fahr., and in the flaky condition is a marketable product. The coagulated blood at the other end is transferred to a blood-drying apparatus, which generally consists of a stationary steam-jacketed drum in which are revolving arms, and these arms by continual agitation serve to liberate the moisture and assist in the reduction of the blood to a dry brown impalpable powder, which usually tests from 14 to 16 per cent. of nitrogen equal to ammonia, and is worth about 9*s*. per unit or from £6 6*s*. to £7 4*s*. per ton.

As already mentioned, the separation of the serum is frequently looked upon as being a waste of time and money, and as a consequence the whole of the blood is frequently put into the drying apparatus and converted into fertiliser, and some handlers of this material carry the process further by boiling up and digesting bones and grinding the digested bones into a powder, which is mixed with the dried blood, and in that way manufacturing a strong fertiliser which finds a ready sale (*see* chapter on By-products).

IMPLEMENTS OF SLAUGHTER

When the establishment of an abattoir is contemplated it is essential to determine what should be the system of slaughter to be carried on. The processes are described in Vol. III., but in order to make our references to this department of the subject complete, it will be necessary to refer briefly to the various apparatus here.

The implements used for slaughter continue to increase in variety year by year, and, mainly owing to the agitation carried on by humanely disposed persons, many implements of precision have been invented, which have had a considerable vogue during recent years.

In slaughtering a bullock the method in use from time immemorial has been by means of the pole-axe, an implement which is familiar to every one in connection with the slaughter of animals. The pole-axe is primarily used for the slaughter of cattle, and is so constructed as to form an axe on the one side and a slaughtering-bolt on the other. In the hands of a skilful slaughterman the pole-axe is a precise weapon, but all men who use it have not had sufficient training to enable them to do so with any degree of certainty. The object of using the pole-axe is to destroy the brain, and a skilful workman will, with one stroke, break the frontal bone in the skull of an animal and perforate the brain instantly, thus causing immediate unconsciousness. An unskilful person may not be so fortunate, and in this way a good deal of unnecessary torture may be inflicted through the swerving of the head of the animal.

In this connection it is notable that in the German abattoirs, where different forms of slaughtering apparatus are used, it is the custom to provide apprentices with an apparatus devised by Stoff, by which they are taught accuracy of aim. The apparatus consists principally of a strong framework which carries a spring arrangement in front, in which there is a bolt terminating with a point. The apprentice has to practise hitting this point so as to make certain that when he takes aim in a similar way on the slaughtering-bolt fixed to the head of an animal, he will not miss it.

In the German abattoirs, slaughtering-bolts of one form or another are used, and are fixed in masks, so that when they are struck by means of a broad mallet there is very little fear of their missing the brain of the animal. The cattle, however, in the German abattoirs are much more docile than the various British breeds, and it would not be possible with some of our wilder animals to use masks at all.

A very old form of mask is that which was invented by a Frenchman, Brunneau, and which is used extensively at the present day in many of the French abattoirs. It consists simply of a leather covering which is fixed over the eyes of the animal, and in the centre of which is a bolt, which may be driven directly into the brain.

Forms of Humane Slaughtering. Of late years, however, the mask has been superseded to a large extent by shooting instruments, and one of these is deservedly very popular, and is called Greener's Humane Cattle-Killer. It consists of a rifled gun-barrel, which is so fixed that it receives a cartridge with a steel-pointed bullet. On the discharge of the cartridge the bullet perforates the skull, proceeds through the brain, and usually is deposited in the spinal cord. It is a very simple apparatus, and answers all the purposes that humane instinct would require, as it produces insensibility with the least amount of trouble to the operator.

Another form of humane slaughtering apparatus is a pistol devised by Behr. A bolt is discharged by means of this apparatus, in place of the bullet. A fulminate cartridge is used and forces a long-pointed bolt out of the barrel of the pistol with great velocity, so that it instantly pierces the brain and causes insensibility. The bolt returns automatically into the barrel of the pistol, thus getting separated from the animal before it falls.

In the slaughter of smaller animals, the usual practice in the United Kingdom is to sever the main arteries in the neck without previous stupefaction, and it would certainly seem as if this practice were capable of modification. In the case of the sheep the next step is the cutting of the spinal cord, insensibility following as a matter of course. It has, however, been considered much more humane to produce insensibility in sheep and calves by means of a heavy club before proceeding to let out the blood. The process certainly appeals to the finer feelings as being in conformity with humanity. There is no kind of general opinion that stunning in any way interferes with the quality of the meat, so that the objection to it arises principally from force of habit and from the fact that workmen do not change readily from one system to another.

American Methods. In American abattoirs, especially those where large numbers of cattle are handled, shooting apparatus of any description are not now generally used, it being the custom to drive the cattle into square pens, over which a platform runs. These pens are so constructed that as the animal walks in it automatically closes the door behind it. The slaughterman, who is situated over the pen, has a light steel mallet with a long handle, as his slaughtering apparatus. He makes a noise on the platform with his feet so as to attract the attention of the animal, and as it raises its head it is at once rendered unconscious by a blow from this small mallet. Immediately it falls, the door of the pen is pushed upwards and the floor inside cants outwards, thus throwing the carcase into the open space outside, where it is at once caught up by gear and hoisted bodily on to overhead tracking, in which position it is dressed.

In large abattoirs, more especially in the United States, much of the work is done by mechanical contrivances which would not be applicable to anything that exists in Europe, and the slaughtering departments referred to, are instances of how mechanics can be applied to such an operation.

Jewish Method of Slaughtering. Another form of killing animals is that practised by the Jews. In an earlier part of this book we referred to the ancient Jewish laws in connection with the handling of meat, which have lasted from the time of Moses to the present day. There is, however, no law with regard to slaughtering, and the method which is at present adopted is one which was authorised by a congregation of learned Rabbis as being in conformity with the principles of the Mosaic law, and calculated to prevent what that law regards as the consumption of unclean meat.

One method of applying the Jewish system of slaughter consists of winding a rope round the animal in such a way as to throw it on its side. While thus lying, the head of the animal is kept in a vertical position, the muzzle being upwards, and by means of an extremely sharp razor-blade the main arteries are instantly severed, the operation being performed by a slaughterman authorised by the Shechita board.

There are objections to the Jewish method owing to the period of time which it takes, and to the struggles to which the animals are liable. To the onlooker also there certainly does appear to be a large amount of unnecessary suffering which would be entirely avoided if stunning preceded the severing of the arteries.

In place of the casting rope, which has been referred to, a mechanical device has been made for the handling of the animal so as to be in conformity with the Jewish requirements, and this apparatus consists of a platform which can be tilted up, so that when the animal has been strapped to a grating on the side, it will then be in a position required for the immediate severing of the arteries. As soon as this has been done the apparatus can be lowered to its original position.

Admiralty Recommendations. It may be remembered that a committee was appointed by the British Admiralty in 1904 to inquire into the slaughtering of animals for food, and they issued their report in 1908. It is a very interesting document, and shows that the members

Comparative Figures relating to Ninety-one of the Public Slaughterhouses provided by Municipalities, Urban District Councils and Royal and Police Burghs in the United Kingdom

(The figures are based on the returns for the year 1908)

Town or District.	Population.	Expenditure on Land and Buildings.	Gross Annual Income.	Animals Slaughtered.				Total Killings.
				Cattle.	Calves.	Sheep and Lambs.	Pigs.	
		£	£					
Alnwick	7,000	1,400	50	1,000	35	3,000	250	4,285
Arbroath	22,500	6,600	200	2,177	37	1,614	985	4,813
Ardrossan	6,077	555	104	578	124	1,748	12	2,462
Ayr	28,624	Old buildings gradually improved	660	3,468	1,792	20,852	1,084	27,196
Barnstaple	14,137	1,200	44	515	33	1,131	140	1,819
Barrow-in-Furness	69,700	16,547	855	3,773	1,365	19,995	4,431	29,564
Barry	33,202	7,362	391	1,654	227	6,965	3,458	12,304
Bathgate	7,000	350	96	840	72	1,697	840	3,449
Belfast	380,000	Not available	2,191	25,577	2,027	33,994	—	61,598
Bideford	8,754	,,	45	307	54	1,277	90	1,728
Birkenhead	121,000	,,	471	1,213	550	10,958	4,037	16,758
Birmingham	558,357	Not available		27,537	23,393	154,406	35,645	240,981
Blackpool	61,080	14,383	540	2,940	736	35,070	1,340	40,086
Blyth	23,351	2,200	77	1,300	200	3,640	300	5.440
Bolton	185,300	12,386	182	409	22	726	—	1,157
Brechin	8,941	Not available	170	769	3	973	364	2,109
Brighouse	21,735	Rented at £50 per annum	80	548	78	1,562	704	2,892
Brighton	129,967	14,000	589	2,374	1,795	10,467	10.253	24,889

Burnley	105,000	12,459	974	6,890	1,104	37,255	5,463	50,712
Burntisland	4,846	Not available	48	406	50	650	25	1,131
Cardiff (Roath)	195,000	,,	2,172	7,955	4,936	41,833	26,260	80,984
Carlisle	50,000	8,204	635	4,000	900	15,500	4,500	24,900
Carnarvon	9,760	2,280	236	1,034	654	9,567	1,461	12,716
Cleckheaton	14,000	Premises are rented	48	338	60	950	500	1,848
Coatbridge	44,008	6,000	595	5,005	255	10,309	700	16,269
Colne	27,000	2,810	30	157	157	714	253	1,281
Cowdenbeath	10,000	18,080	123	1,775	50	1,297	457	3,579
Croydon	161,078	4,232	305	696	3,894	6,365	18,525	29,480
Denny	5,124	1,360	131	708	440	594	139	1,881
Douglas (Isle of Man)	23,000	6,146	355	2,143	137	12,910	791	15,981
Dundee	169,409	47,550	4,752	16,120	319	33,291	3,299	53,029
Edinburgh	350,761	Under reconstruction	4,616	28,081	4,397	177,800	7,879	218,157
Elgin	8,407	Not available	150	1,325	2	6,578	324	8,229
Exeter	48,000	4,657	219	2,185	758	5,535	2,042	10,520
Forfar	11,397	1,700	228	1,411	24	11,364	1,401	14,200
Fraserburgh	10,380	1,250	180	2,346	—	3,052	217	5,615
Glasgow	859,715	Accounts not kept separate from markets, &c.		60,165	5,170	264,928	51,860	382,123
Grangemouth	9,500	800	97	2,720	—	—	—	2,720
Greenock	68,115	7,851	896	5,729	1,973	19,294	1,192	28,188
Hanley	67,000	Amount included in cost of markets	374	4,134	400	3,412	6,099	14,045
Hereford	21,382	Not available	240	1,492	428	7,241	2 019	11,180
Hexham	7,071	2,000	110	1,037	225	4,925	585	6,772
Huddersfield	95,047	16,590	939	4,070	3,076	17,288	9,891	34,325
Ilkley	8,500	2,000	122	455	240	4,402	844	5,941
Inverness	24,500	3,300	455	2,987	177	29.229	778	33,171

COMPARATIVE FIGURES RELATING TO NINETY-ONE OF THE PUBLIC SLAUGHTERHOUSES—(*continued*)

Town or District.	Population.	Expenditure on Land and Buildings.	Gross Annual Income.	Animals Slaughtered.				Total Killings.
				Cattle.	Calves.	Sheep and Lambs.	Pigs.	
		£	£					
Kilmarnock	34,165	2,770	209	2,337	457	6,867	105	9,766
Kilsyth	7,331	900	216	2,376	68	2,882	535	5,861
Kilwinning	4,589	1,100	78	547	43	859	215	1,664
Kirkcaldy	34,063	Old buildings not available		3,257	210	6,368	687	10,522
Kirkcudbright	2,300	600	36	316	2	973	15	1,306
Kirkwall	3,711	Not available		691	10	823	71	1,595
Leeds	477,107	Accounts not kept separate from markets, &c.		8,147	7,066	33,903	572	49,688
Leicester	235,000	,,	,,	4,500	1,500	10,400	15,000	31,400
Leith	84,172	4,900	367	3,788	—	4,798	946	9,532
Linlithgow	4,279	1,400	103	427	66	636	238	1,367
Llanelly	25,617	1,953	443	1,794	1,329	11,457	4,604	19,184
Lochgelly	7,250	1,750	180	1,445	4	1,188	347	2,984
Lytham	10,500	3,000	123	577	279	6,590	139	7,585
Manchester	606,000	Accounts not kept separate from markets, &c.		35,179	1,936	194,585	12,806	244,506
Maryport	12,400	1,070	120	895	115	2,764	1,074	4,848
Morpeth	6,158	1,200	78	884	55	2,810	756	4,505
Musselburgh	11,704	Not available	261	1,162	67	4,211	536	5,976
Northampton	92,750	960	5	41	1	157	179	378
North Berwick	2,784	2,362	93	426	6	3,382	56	3,870
Oswa'dtwistle	14,192	800	56	Not available			600	
Peebles	5,800	1,980	127	695	30	3,425	82	4,232
Perth	35,195	5,965	474	3,630	232	26,363	1,521	31,746

Pontypridd	37,000	15,000	500	1,600	1,700	9,400	2,900	15,600
Port Glasgow	16,500	1,650	171	1,302	75	2,600	21	3,998
Pwllheli	3,675	830	76	281	149	3,394	486	4,310
Reading	82,549	3,800	216	122	130	766	608	1,626
Rotherham	65,200	Accounts not kept separate from markets, &c.		4,885	142	7,343	2,203	14,573
Rothesay	9,303	1,500	145	876	206	4,080	115	5,277
St. Andrews	7,621	1,881	117	729	73	3,806	247	4,855
St. Anne's-on-the-Sea	10,700	2,650	70	309	158	3,125	156	3,748
St. Helen's (Lancs.)	92,500	7,779	591	2,944	400	3,053	5,791	12,188
Sanquhar	13,751	425	41	205	20	1,203	4	1,432
Sheffield	471,000	Not available	745	5,616	4,108	20,436	40	30,200
Shipley	28,750	4,500	396	2,687	2,315	467	5,490	10,959
Slaithwaite	4,763	4,000	83	616	206	1,510	1,368	3,700
Southport	53,000	4,857	263	1,457	1,188	20,914	141	23,700
South Shields	117,629	20,000	772	4,886	671	30,918	7,676	44,151
Swansea	107,620	10,556	1,921	5,200	1,000	19,200	13,700	39,100
Troon	6,000	600	85	682	1	2,483	73	3,239
Wakefield	43,611	Not available	227	2,352	360	5,664	804	9,180
West Hartlepool	70,000	8,200	670	4,334	680	10,909	6,714	22,637
Weston-super-Mare	22,000	1,700	298	304	433	2,370	3,870	6,977
Wishaw	23,487	2,853	433	3,751	643	8,090	944	13,428
Worcester	49,500	823	120	476	398	1,454	2,152	4,480
Workington	26,143	800	157	1,802	129	6,897	1,662	10,490
Wrexham	17,000	2,000	107	936	1,040	6,656	5,252	13,884

of the committee took considerable pains to arrive at clear conclusions.* After fully considering the various proposals, it was recommended that the following regulations should be enforced in connection with public abattoirs (*see* p. 11 of Report):

(*a*) All animals, without exception, must be stunned, or otherwise rendered unconscious before blood is drawn.

(*b*) Animals awaiting slaughter must be so placed that they cannot see into the slaughterhouse, and the doors of the latter must be kept closed whilst slaughtering goes on.

(*c*) The drainage of the slaughterhouse must be so arranged that no blood or other refuse can flow out within the sight or smell of animals awaiting slaughter, and no such refuse shall be deposited in proximity to the waiting-pens.

(*d*) If more animals than one are being slaughtered in one slaughterhouse at the same time, they must not be within view of each other.

(*e*) None but licensed men shall be employed in or about slaughterhouses.

MODEL BYLAWS ISSUED BY THE LOCAL GOVERNMENT BOARD FOR THE REGULATION OF SLAUGHTERHOUSES, 1909

Memorandum

Section 169 of the Public Health Act, 1875 (38 & 39 Vict. c. 55), enacts that " for the purpose of enabling any Urban Authority to regulate slaughterhouses within their district, the provisions of the Towns Improvement Clauses Act, 1847 [10 & 11 Vict. c. 34], with respect to slaughterhouses, shall be incorporated with this Act."

Of the incorporated provisions of the Towns Improvement Clauses Act, 1847, sec. 128 is in the following terms:

" The Commissioners [Urban Authority] shall, from time to time, by bylaws . . . make regulations for the licensing, registering and inspection of the . . . slaughterhouses . . . and preventing cruelty therein, and for keeping the same in a cleanly and proper state, and for removing filth at least once in every twenty-four hours, and requiring them to be provided with a sufficient supply of water; and they may impose pecuniary penalties on persons breaking such bylaws; provided that no such penalty exceed for any one offence the sum of five pounds, and in the case of a continuing nuisance the sum of ten shillings for every day during which such nuisance shall be continued after the conviction for the first offence."

By the next section (129), it is provided that the " justices before whom any person is convicted of killing or dressing any cattle contrary to the provisions of this or the special Act [*i.e.*, the Public Health Act, 1875], or of the non-observance of any of the bylaws or regulations made by virtue of this or the special Act, in addition to the penalty imposed on such person under the authority of this or the special Act, may suspend, for any period not exceeding two months, the licence granted to such person under this or the special Act, or in case such person be the owner or proprietor of any registered slaughterhouse . . . may forbid, for any period not exceeding two months, the slaughtering of cattle therein ; and such justices, upon the conviction of any person for a second or other subsequent like offence, may, in addition to the penalty imposed under the authority of this or the special Act, declare the licence granted under this or the special Act, revoked, or if such person be the owner or proprietor of any registered slaughterhouse, may forbid absolutely the slaughtering of cattle therein ; and whenever the licence of any such person is revoked as aforesaid, or whenever the slaughtering of cattle in any registered slaughterhouse . . . is absolutely forbidden as aforesaid, the Commissioners may refuse to grant any licence whatever to the person whose licence has been so revoked, or on account of whose default the slaughtering of cattle in any registered slaughterhouse has been forbidden."

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* Report of the Committee appointed by the Admiralty to consider the Humane slaughtering of Animals. H.M. Stationery Office, 1908.

Further, by section 130 of the Towns Improvement Clauses Act, 1847, it is enacted that "every person who during the period for which any such licence is suspended, or after the same is revoked as aforesaid, slaughters cattle in the slaughterhouse . . . to which such licence relates, or otherwise uses such slaughterhouse . . . or allows the same to be used as a slaughterhouse . . . , and every person who during the period that the slaughtering of cattle in any such registered slaughterhouse . . . is forbidden as aforesaid, or after such slaughtering has been absolutely forbidden therein, slaughters any cattle in any such registered slaughterhouse, shall be liable to a penalty not exceeding five pounds for such offence, and a further penalty of five pounds for every day on which any such offence is committed after the conviction for the first offence."

In connection with these provisions, and those relating to the licensing and registration of slaughterhouses, in secs. 125–127, the attention of the Urban Authority should be directed to the judgment of the Court of Exchequer Chamber in the case of *Anthony* v. *The Brecon Markets Company* (26 L.T., N.S., 982).

With reference to that judgment, a few observations may here be introduced in illustration of the nature and extent of the powers of the Urban Authority with regard to slaughterhouses.

It will be seen that the provisions of the Towns Improvement Clauses Act, 1847, incorporated with the Public Health Act, 1875, by sec. 169 of the latter Act, recognise two classes of slaughterhouses, viz., slaughterhouses in use and occupation at the time of the passing of the "special Act," and slaughterhouses not in use and occupation at that time. To the former class the requirements as to registration in sec. 127 are specially applicable. To the latter class the provisions as to licensing in secs. 125 and 126 have direct reference.

Both classes may apparently be regulated by bylaws under sec. 128.

In framing a model series of bylaws under that enactment, the Board have considered that the statutory terms do not warrant the extension of the scope of the bylaws to regulations directly affecting the structure of the premises.

But as regards premises for which under sec. 126 the licence of the Urban Authority will be required, the Board have been advised that, in the exercise of the discretionary power of licensing which has been conferred upon the Urban Authority, the following rules as to site and structure should influence their decision upon each application for a licence :

(1) The premises to be erected or to be used and occupied as a slaughter-house should not be within 100 ft. of any dwelling-house ; and the site should be such as to admit of free ventilation by direct communication with the external air on two sides at least of the slaughterhouse.

(2) Lairs for cattle in connection with the slaughterhouse should not be within 100 ft. of a dwelling-house.

(3) The slaughterhouse should not in any part be below the surface of the adjoining ground.

(4) The approach to the slaughterhouse should not be on an incline of more than 1 in 4, and should not be through any dwelling-house or shop.

(5) No room or loft should be constructed over the slaughterhouse.

(6) The slaughterhouse should be provided with an adequate tank or other proper receptacle for water, so placed that the bottom shall not be less than 6 ft. above the level of the floor of the slaughterhouse.

(7) The slaughter-house should be provided with means of thorough ventilation.

(8) The slaughterhouse should be well paved with asphalt or concrete and laid with proper slope and channel towards a gully, which should be properly trapped and covered with a grating, the bars of which should be not more than three-eighths of an inch apart.

Provision for the effectual drainage of the slaughterhouse should also be made.

(9) The surface of the walls in the interior of the slaughterhouse should be covered with hard, smooth, impervious material, to a sufficient height.

(10) No water-closet, privy or cesspool, should be constructed within the slaughterhouse.

There should be no direct communication between the slaughter-house and any stable, water-closet, privy or cesspool.

(11) Every lair for cattle in connection with the slaughterhouse should be properly paved, drained and ventilated.

(12) No habitable room should be constructed over any lair.

It remains to call attention to two provisions contained in the Public Health Acts Amendment Act, 1890 (53 & 54 Vict. c. 59), which apply in cases where Part III. of that Act has been adopted by an Urban Authority :

(*a*) Under sec. 29 the Urban Authority may limit the duration of licences granted, after the adoption of Part III., for the use and occupation of places as slaughterhouses so that such licences "shall be in force for such time or times only, not being less than twelve months, as the Urban Authority shall think fit to specify in such licences." Certain forms which are prescribed by the model causes will be found to give effect to this provision.

(*b*) Where a licence for the use and occupation of a slaughterhouse is granted, after the adoption of Part III., the provisions of sec. 30 of that Act are required by sub-sec. (3) of that section to be endorsed on the licence. This enactment prescribes that upon any change of occupation of any building within an Urban District registered or licensed for use and used as a slaughterhouse, the person thereupon becoming the occupier or joint occupier, shall give notice in writing of the change of occupation to the inspector of nuisances. A person failing or neglecting to give the notice becomes liable to a penalty. (Sec. 30 (2).)

S. B. PROVIS,
Secretary.

Local Government Board,
November 1900.

REVISE OF 1909

In preparing a new edition of this series of bylaws, the Board, in view of the recommendations of the Committee appointed by the Admiralty to consider the Humane Slaughtering of Animals,* have added three new clauses, Nos. 9, 11 and 12, for preventing cruelty in slaughterhouses.

Clause 9 is inserted with a view to carry out the recommendation of the Committee, that "all animals, without exception, must be stunned or otherwise rendered unconscious before blood is drawn."

While, however, the Board concur in the principle of this recommendation, it must be remembered that attempts at stunning, carelessly or unskilfully made, may be the means of inflicting, instead of avoiding, unnecessary pain, and hence the Board suggest that, before making a bylaw requiring the stunning of any animal other than horned cattle, the local authority should ascertain how far the butchers in the district are prepared to carry out the practice. In relation to this question the Board have been advised by the Board of Agriculture and Fisheries that they would see no objection to a bylaw requiring the stunning of pigs or calves, but that the stunning of sheep is a difficult operation, in the carrying out of which cruelty might easily occur. On the other hand the Committee satisfied themselves that sheep can be stunned expeditiously and without difficulty, by striking them on the top of the head between the ears—not on the forehead—with a small club having a heavy head ; and they state that in Denmark, many parts of Germany and Switzerland, the law requires that sheep shall always be stunned previous to being stuck. But while the practice of stunning sheep may be a proper one to adopt in public abattoirs, where it will be carried out by skilled slaughtermen, the Board doubt whether it is advisable to require its adoption in private establishments unless there is reasonable ground for believing that it will be properly performed.

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* *See* the Report of the Committee—Parliamentary Paper (Cd. 2150), 1904.

The Board have also thought it right, in view of representations which have been made to them by the Jewish authorities, to add a proviso permitting slaughtering by the Jewish method, under proper conditions. This method is described in a report by the late Sir Michael Foster, F.R.S., and Professor Starling, F.R.S., appended to the Report of the Admiralty Committee (Appendix J.). The liability to the infliction of unnecessary suffering appears to occur especially in the preliminary throwing of the bullock and extension of the neck. The duration of consciousness to pain after the actual cutting of the throat, if skilfully performed, was estimated by Sir M. Foster as in different instances from something less than 5 seconds to something less than 40 seconds.

Clauses 11 and 12 are inserted with a view to carry out the recommendation of the Admiralty Committee, that animals awaiting slaughter should be spared as far as possible from any contact with the sights or smells of the slaughterhouse. The Committee say "as an animal cannot speak it is impossible to accurately determine to what extent it does or does not suffer from fear, but there is no doubt that cattle especially frequently show great reluctance to entering the slaughter-chamber and can only be dragged in by the employment of considerable force." The presumption is, that what they chiefly object to is the smell of blood; but whether this can be proved or not the Committee recommend that the animals should be given the full benefit of the doubt.

S. B. PROVIS,
Secretary.

Local Government Board,
April 1909.

[NOTE. *Any local Authority proposing to make bylaws on this subject should apply to the Local Government Board for a form on which to submit a draft of the bylaws for the Board's preliminary approval.*]

BYLAWS made by the [*]

with respect to SLAUGHTERHOUSES in the [†]

Interpretation

(1) Throughout these bylaws the expression "the Council" means the [*]

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[*] Mayor, Aldermen, and Burgesses of the Borough of , acting by the Council"; *or* "Urban [*or* Rural] District Council of , *as the case may be.*

[†] *Insert* "Borough of "; *or* Urban [*or* Rural] District of " *or, if the bylaws are to apply to part only of a rural district,* "that portion of the Rural District of which comprises the contributory places of ," *as the case may be.*

For the licensing, registering and inspection of slaughterhouses, for preventing cruelty therein, for keeping the same in a cleanly and proper state, for removing filth at least once in every twenty-four hours, and requiring such slaughterhouses to be provided with a sufficient supply of water.

(2) Every person who shall apply to the Council for a licence for the erection of any premises to be used and occupied as a slaughterhouse shall furnish in the form hereunto appended a true statement of the particulars therein required to be specified.

FORM OF APPLICATION
FOR
A LICENCE

To erect premises for use and occupation as a Slaughterhouse.

To the *

I, , of

, do hereby apply to you for a licence, in pursuance of the statutory provisions in that behalf, for the erection of certain premises to be used and occupied as a slaughterhouse [† subject to the condition that a licence, which shall be in force for a period of , be granted by you in respect of such use and occupation]: and I do hereby declare that to the best of my knowledge and belief the Schedule hereunto annexed contains a true statement of the several particulars therein set forth with respect to the said premises.

SCHEDULE.

(1) Boundaries, area, and description of the proposed site of the premises to be erected for use and occupation as a slaughterhouse.	
(2) Description of the premises to be erected on such site: (*a*) Nature, position, form, superficial area and cubical contents of the several buildings therein comprised. (*b*) Extent of paved area in such buildings, and materials to be employed in the paving of such area. (*c*) Mode of construction of the internal surface of the walls of such buildings, and materials to be employed in such construction. (*d*) Means of water-supply,—position, form, materials, mode of construction and capacity of the several cisterns, tanks, or other receptacles for water to be constructed for permanent use in or upon the premises. (*e*) Means of drainage,—position, size,	

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* "Town Council of the Borough of "; *or* "Urban [*or* Rural] District Council of "; *as the case may be.*

† Where sec. 29 of the Public Health Acts Amendment Act, 1890, is not in force, omit the words in brackets.

materials and mode of construction of the several drains.

(*f*) Means of lighting and ventilation.

(*g*) Means of access for cattle from the nearest street or public thoroughfare.

(*h*) Number, position and dimensions of the several pounds, stalls, pens or lairs to be provided on the premises.

(*i*) Number of animals for which accommodation will be provided in such pounds, stalls, pens or lairs, distinguishing :

(1) Oxen.
(2) Calves.
(3) Sheep and lambs.
(4) Swine.

Witness my hand this day of 19 .

(*Signature of Applicant.*)

(*Address of Applicant.*)

(3) Every person who shall apply to the Council for a licence for the use and occupation of any premises as a slaughterhouse shall furnish, in the form hereunto appended, a true statement of the particulars therein required to be specified.

FORM OF APPLICATION FOR A LICENCE

For the use and occupation of premises as a Slaughterhouse.

To the *

I, , of , , do hereby apply to you for a licence, in pursuance of the statutory provisions in that behalf, for the use and occupation as a slaughterhouse of the premises hereinafter described [† for a period of from the date of such licence] ; and I do hereby declare that to the best of my knowledge and belief the Schedule hereunto annexed contains a true statement of the several particulars therein set forth with respect to the said premises.

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* "Town Council of the Borough of " ; *or* "Urban [*or* Rural] District Council of " ; *as the case may be.*

† Where sec. 29 of the Public Health Acts Amendment Act, 1890, is not in force, omit the words in brackets.

SCHEDULE

(1) Situation and boundaries of the premises to be used and occupied as a slaughter-house.	
(2) Christian name, surname, and address of the owner of the premises.	
(3) Nature and conditions of applicant's tenure of the premises : (*a*) For what term ; and whether by lease or otherwise. (*b*) Whether applicant is sole owner, lessee, or tenant ; or whether applicant is jointly interested with any other person or persons, and if so, with whom.	
(4) Description of the premises : (*a*) Nature, position, form, superficial area and cubical contents of the several buildings therein comprised. (*b*) Extent of paved area in such buildings, and materials employed in the paving of such area. (*c*) Mode of construction of the internal surface of the walls of such buildings and materials employed in such construction. (*d*) Means of water-supply,—position, form, materials, mode of construction and capacity of the several cisterns, tanks, or other receptacles for water, constructed for permanent use in or upon the premises. (*e*) Means of drainage,—position, size, materials, and mode of construction of the several drains. (*f*) Means of lighting and ventilation. (*g*) Means of access for cattle from the nearest street or public thoroughfare. (*h*) Number, position and dimensions of the several pounds, stalls, pens or lairs provided on the premises. (*i*) Number of animals for which accommodation will be provided in such pounds, stalls, pens or lairs distinguishing ; (1) Oxen. (2) Calves. (3) Sheep and lambs. (4) Swine.	

Witness my hand this day of 19 .

(*Signature of Applicant.*)

(*Address of Applicant.*)

(4) Every person to whom the Council may have resolved that a licence be granted to erect premises for use and occupation as a slaughter-house shall be entitled to receive from the Council a licence in the form hereunto appended, or to the like effect.

FORM OF LICENCE

To erect premises for use and occupation as a Slaughterhouse.

No. of Licence } ________

Reference to Folio in Register } ________

Borough [*or* Urban (*or* Rural) District] of .

Whereas application has been made to us, the * , by , of for a licence to erect on a site within the said Borough [*or* District] certain premises for use and occupation as a slaughterhouse :

Now, we, the said Council, in pursuance of the powers conferred upon us by the statutory provisions in that behalf, do hereby license the said , of , , to erect upon the site defined or described in the Schedule hereunto annexed the premises whereof the description is set forth in the said Schedule, and which may be used and occupied as a slaughterhouse [† subject to the condition that a licence, which shall be in force for a period of be granted by us, in respect of such use and occupation].

* "Town Council of the Borough of " ; *or* "Urban [*or* Rural] District Council of " ; *as the case may be.*

† Where sec. 29 of the Public Health Acts Amendment Act, 1890, is not in force, omit the words in brackets.

SCHEDULE

Boundaries, area, and description of the proposed site of the premises to be erected for use and occupation as a slaughterhouse.	Description of the premises to be erected for use and occupation as a slaughterhouse.

Given under the Common Seal of the

this day of , in the year One thousand nine hundred and

L. S.

Town Clerk (or *Clerk to the Council*).

(5) Every person to whom the Council may have resolved that a licence be granted for the use and occupation of any premises as a slaughterhouse shall be entitled to receive from the Council a licence in the form hereunto appended, or to the like effect.

FORM OF LICENCE

For the use and occupation of premises as a Slaughterhouse.

No. of Licence __________

Reference to Folio in Register __________

Borough [or Urban (or Rural) District] of .

Whereas application has been made to us, the * , by , of , for a licence for the use and occupation of certain premises as a slaughterhouse : ,

Now, we, the said Council, in pursuance of the powers conferred upon us by the statutory provisions in that behalf, do hereby license the said , of , , to use and occupy as a slaughterhouse the premises whereof the situation and description are set forth in the Schedule hereunto annexed [†for a period of from the date hereof].

* "Town Council of the Borough of " ; *or* "Urban [*or* Rural] District Council of " ; *as the case may be.*

† Where sec. 29 of the Public Health Acts Amendment Act, 1890, is not in force, omit the words in brackets.

SCHEDULE

Situation of the premises to be used and occupied as a slaughterhouse.	Description of the premises to be used and occupied as a slaughterhouse.

Given under the Common Seal of the

this day of , in the year One thousand nine hundred and

L. S.

Town Clerk (or *Clerk to the Council*).

(6) Every person who may have obtained from the Council, in accordance with the provisions of the bylaw in that behalf, a licence to erect any premises for use and occupation as a slaughterhouse, or a licence for the use and occupation of any premises as a slaughterhouse, shall register such premises at the offices of the Council.

He shall, for such purpose, apply, by notice in writing addressed to the clerk to the Council, to register such premises; and thereupon it shall be the duty of the clerk to the Council, within a reasonable time after the receipt of such notice in writing, to enter in a book to be provided by the Council in the form hereunto appended the particulars therein required to be specified.

FORM OF REGISTER OF SLAUGHTERHOUSES

Borough [*or* Urban (*or* Rural) District] of

Folio

Date of registration.	Particulars of licence.					Christian name, surname, and address of owner of slaughterhouse.	Christian name, surname, and address of occupier of slaughterhouse.	Situation of slaughter-house.	Number of animals for which accommodation is provided on the premises.			
	For erection of slaughter-house.		For use and occupation of slaughter-house.									
	No. of licence.	Date of licence.	No. of licence.	Date of licence.	Period of duration of licence.*				Oxen.	Calves.	Sheep and lambs.	Swine.
1	2	3	4	5	6	7	8	9	10	11	12	13

(7) Every occupier of a slaughterhouse shall, at all reasonable times, afford free access to every part of the premises to the Medical Officer of Health, the Inspector of Nuisances, or the Surveyor of the Council, or to any Committee specially appointed by the Council in that behalf, for the purpose of inspecting such premises.

(8) Every occupier of a slaughterhouse shall cause every animal brought to such slaughterhouse for the purpose of being slaughtered, and confined in any pound, stall, pen or lair upon the premises previously to being slaughtered, to be provided during such confinement with a sufficient quantity of wholesome water.

(9) A person shall not, in a slaughterhouse, proceed to slaughter any

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* Where sec. 29 of the Public Health Acts Amendment Act, 1890, is not in force, omit column 6.

bull, ox, cow, heifer, calf or pig, until the same shall have been effectually stunned.

Provided that this requirement shall not be deemed to apply to any member of the Jewish faith, duly licensed by the Chief Rabbi as a Slaughterer, when engaged in the slaughtering of cattle intended for the food of Jews according to the Jewish method of slaughtering, if no unnecessary suffering is inflicted.

(10) Every occupier of a slaughterhouse and every servant of such occupier and every other person employed upon the premises in the slaughtering of cattle shall, before proceeding to slaughter any bull, ox, cow, heifer or steer, cause the head of such animal to be securely fastened so as to enable such animal to be felled with as little pain or suffering as practicable, and shall in the process of slaughtering any animal use such instruments and appliances and adopt such method of slaughtering and otherwise take such precautions as may be requisite to secure the infliction of as little pain or suffering as practicable.

(11) A person shall not, in a slaughterhouse, slaughter, or cause or suffer to be slaughtered, any animal in the view of another animal.

(12) An occupier of a slaughterhouse shall not cause or allow any blood or other refuse to flow from such slaughterhouse so as to be within the sight or smell of any animal in the slaughterhouse, and he shall not cause or allow any such blood or other refuse to be deposited in the waiting-pens or lairs.

(13) Every occupier of a slaughterhouse shall cause the means of ventilation provided in or in connection with such slaughterhouse to be kept at all times in proper order and efficient action; and so that the ventilation shall be by direct communication with the external air.

(14) Every occupier of a slaughterhouse shall cause the drainage provided in or in connection with such slaughterhouse to be kept at all times in proper order and efficient action.

(15) Every occupier of a slaughterhouse shall cause every part of the internal surface of the walls and every part of the floor or pavement of such slaughterhouse to be kept at all times in good order and repair, so as to prevent the absorption therein of any blood or liquid refuse or filth which may be spilled or splashed thereon, or any offensive or noxious matter which may be deposited thereon or brought into contact therewith.

He shall cause every part of the internal surface above the floor or pavement of such slaughterhouse to be thoroughly washed with hot lime-wash at least four times in every year; that is to say, at least once during the periods between the *first* and *tenth* of *March*, the *first* and *tenth* of *June*, the *first* and *tenth* of *September*, and the *first* and *tenth* of *December* respectively.

He shall cause every part of the floor or pavement of such slaughterhouse, and every part of the internal surface of every wall on which any blood or liquid refuse or filth may have been spilled or splashed, or with which any offensive or noxious matter may have been brought into contact during the process of slaughtering or dressing in such slaughterhouse, to be thoroughly washed and cleansed within *three hours* after the completion of such slaughtering or dressing.

(16) An occupier of a slaughterhouse shall not at any time keep any dog, or cause or suffer any dog to be kept in such slaughterhouse.

He shall not at any time keep, or cause or suffer to be kept in such slaughterhouse any animal of which the flesh may be used for the food of man, unless such animal be so kept in preparation for the slaughtering thereof upon the premises.

He shall not at any time keep any cattle, or cause or suffer any cattle to be kept in such slaughterhouse for a longer period than may be necessary for the purpose of preparing such cattle for the process of slaughtering.

If, at any time, he keep, or suffer to be kept in such slaughterhouse any cattle for the purpose of preparation for the process of slaughtering, he shall not cause or suffer such cattle to be confined elsewhere than in the pounds, stalls, pens or lairs provided on the premises.

(17) Every occupier of a slaughterhouse shall cause the hide or skin, fat, and offal of every animal slaughtered on the premises to be removed therefrom within *twenty-four hours* after the completion of the slaughtering of such animal.

Sections (18) and (19) provide for a proper water-supply, the provision of receptacles for residues, blood, &c., and general hygienic arrangements. The regulations then proceed to deal with penalties.

(20) Every person who shall offend against any of the foregoing by-laws for the registering and inspection of slaughterhouses, for preventing cruelty therein, for keeping the same in a cleanly and proper state, for removing filth at least once in every twenty-four hours, and for requiring such slaughterhouses to be provided with a sufficient supply of water, shall be liable for every such offence to a penalty of *five pounds*, and in the case of a continuing nuisance to a penalty of *ten shillings* for every day during which such nuisance shall be continued after the conviction for the first offence:

Provided nevertheless, that the justices or court before whom any complaint may be made or any proceedings may be taken in respect of any such offence may, if they think fit, adjudge the payment as a penalty of any sum less than the full amount of the penalty imposed by this by-law.

(21) From and after the date of the confirmation of these bylaws, the bylaws relating to slaughterhouses which were made by the

on the day of in the year
one thousand hundred and and
which were confirmed by [one of Her late Majesty's Principal Secretaries of State] [the Local Government Board] on the day of
in the year one thousand hundred and
, shall be repealed.

*Repeal of By-laws.**

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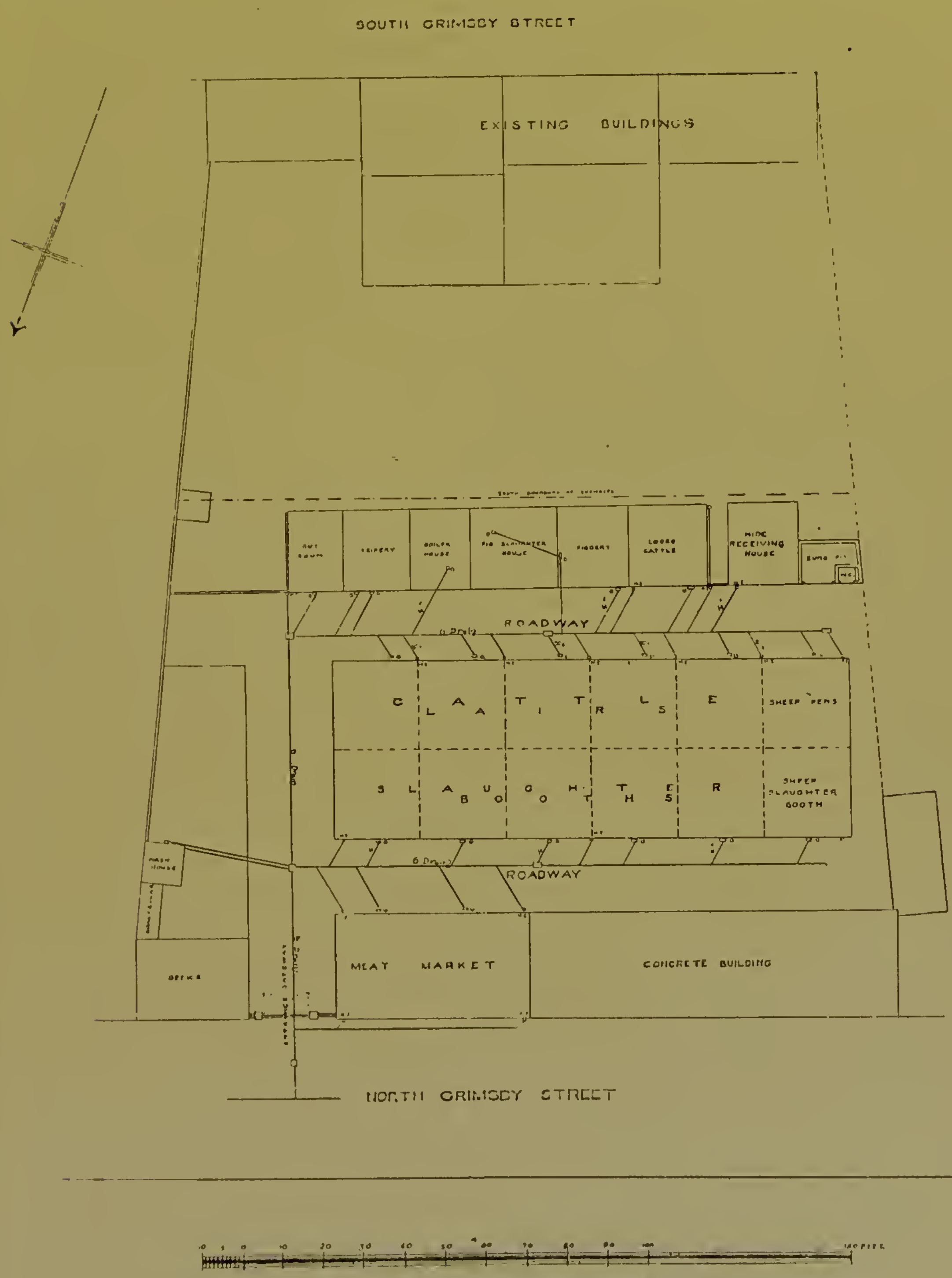
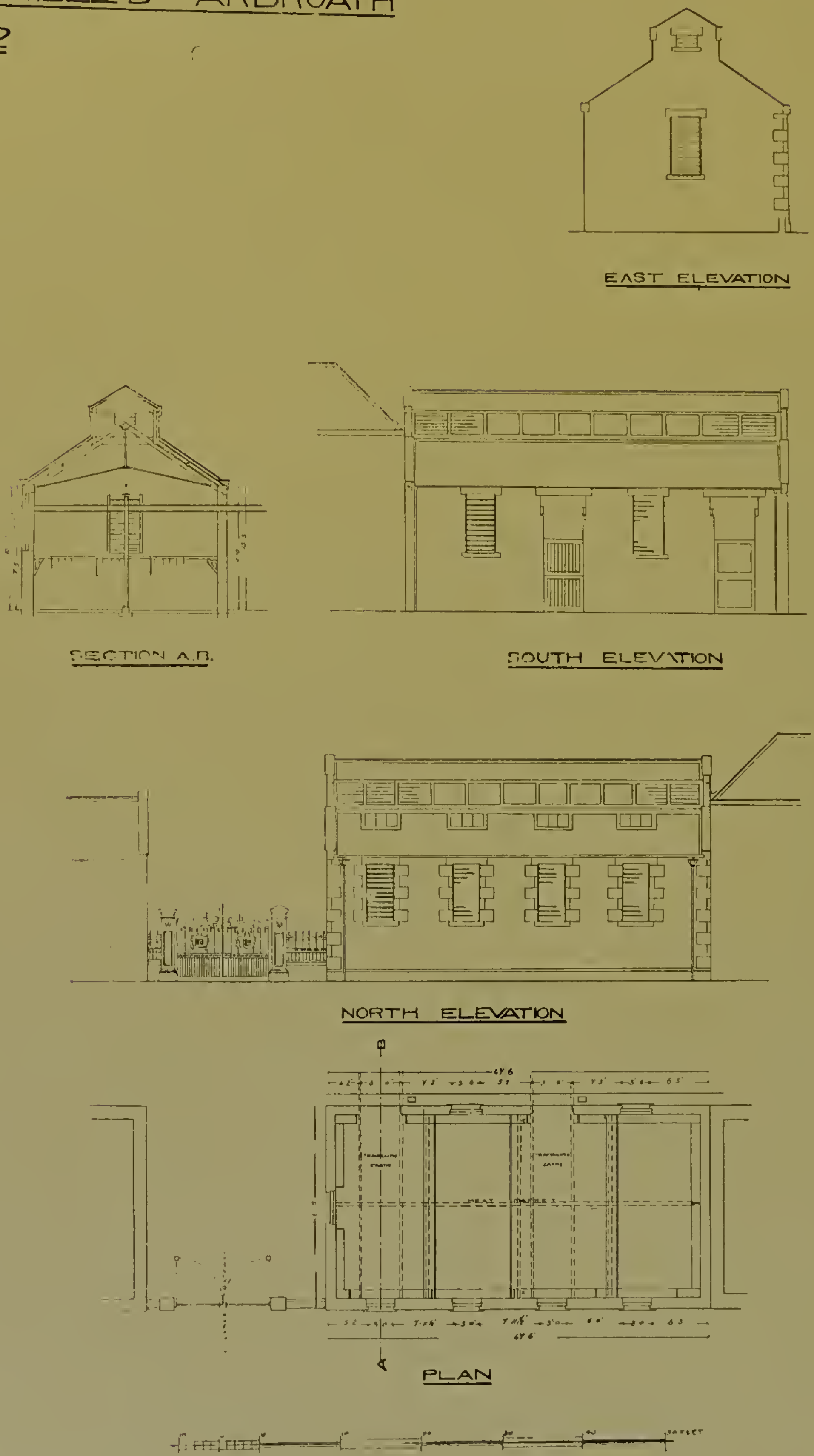
* If this clause is not included in the series submitted to the Local Government Board for approval, it should be stated whether or not there are any bylaws in force upon the subject.

A PROVINCIAL SLAUGHTERHOUSE
A SERIES OF PLANS SHOWING THE ARRANGEMENTS OF A TYPICAL ABATTOIR

SHAMBLES — ARBROATH

— No 1 —

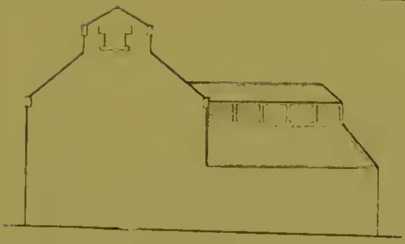




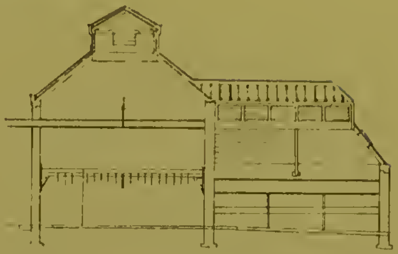
SHAMBLES—ARBROATH —No 2

SHAMBLES – ARBROATH

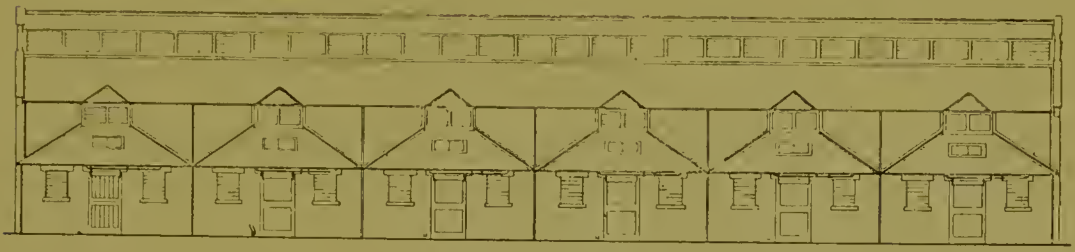
– Nº 3 –



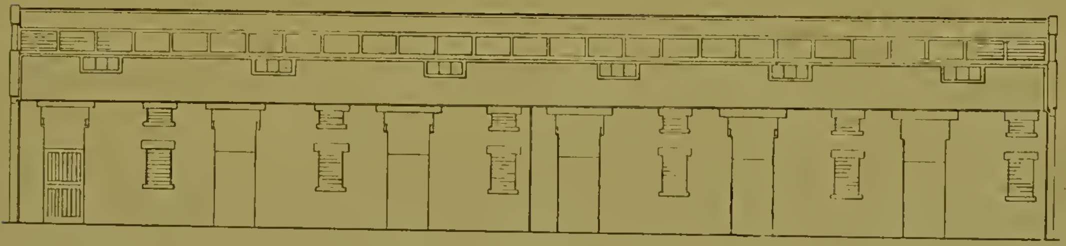
WEST ELEVATION.



SECTION AB.



SOUTH ELEVATION.



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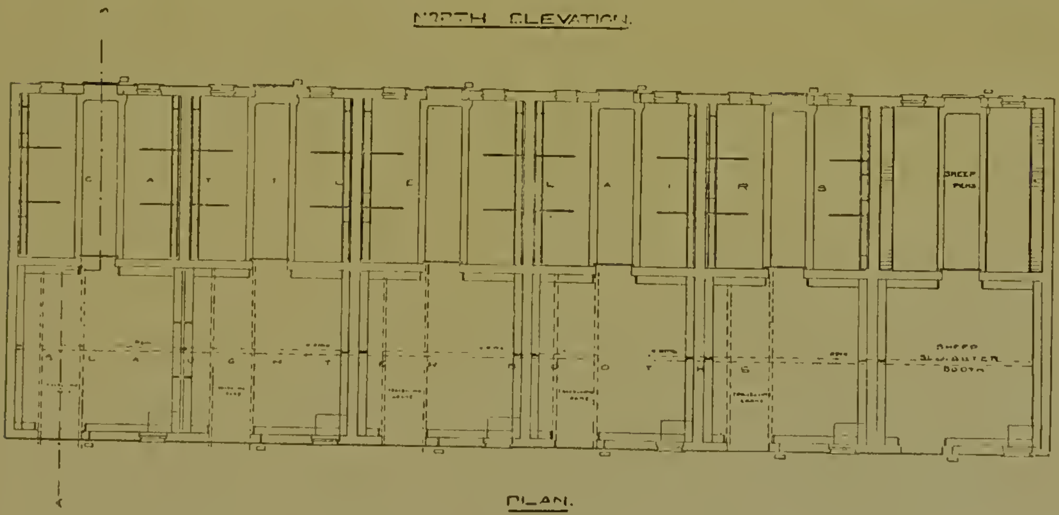

PLAN.

SHAMBLES-ARBROATH.

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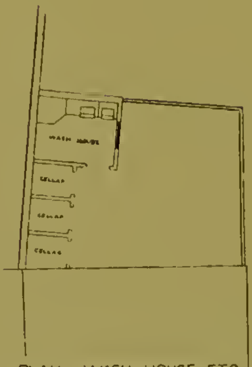
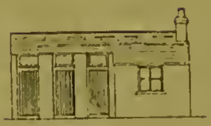


PLAN OF WASH-HOUSE ETC



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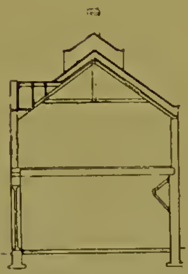
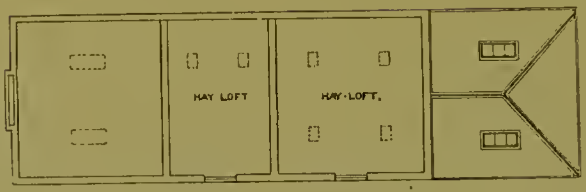
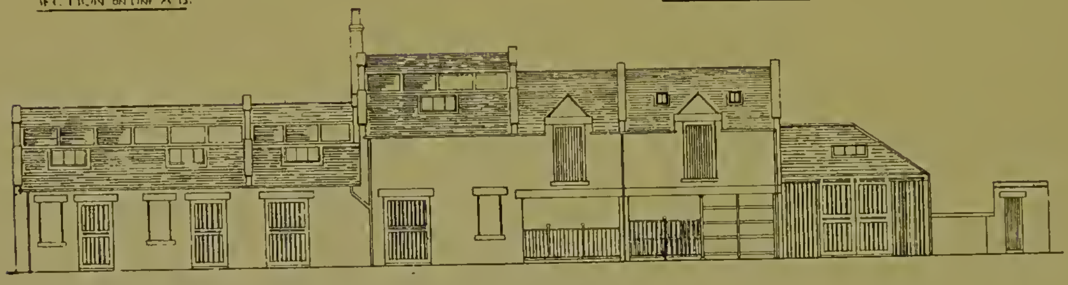


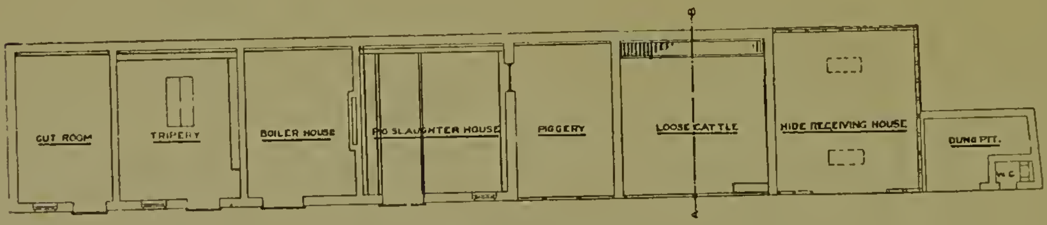
SECTION ON LINE A B.



UPPER FLOOR PLAN



NORTH ELEVATION



GROUND FLOOR PLAN

CHAPTER IV

THE MEAT-SUPPLY OF THE UNITED KINGDOM *

THE change from a national to an international meat trade, has occurred mainly during the last half-century, but more particularly within the last quarter of a century, and this has come about by improvement in the means of transport.

In considering the meat-supply, however, it is necessary to look at the figures which show the world's supply of live-stock. The distribution of animals reared throughout the world for human consumption shows where our future supplies are likely to come from.

To attempt an estimate of the number of cattle, sheep or pigs on the globe is a difficult task. It is clear, in the first place, that such an estimate must be confined to those countries that are sufficiently civilised to take some sort of census of their live-stock. Most civilised countries now do this, at varying intervals; and as these comprise practically all the sources of any importance in international trade, we may, without too much danger, form an idea of the live-stock in the "meat-trade world."

This, of course, excludes enormous areas such as China, Africa, India and the larger portion of South America. The total is a sort of net available quantity for the countries which either require help from outside or offer it to others.

An enumeration of "cattle" in some countries includes buffaloes, or at least does not always distinguish them clearly (*e.g.* India), and probably other animals closely allied to the European *Bos* are sometimes swept into the statistical net. Indeed, it would not be possible to draw a distinction that the uneducated mind of the peasant in many countries could appreciate. As regards sheep, matters are not on any better footing. Most countries enumerate goats separately, but a few include them with sheep. And the latter are frequently right. In the United Kingdom we know the difference between a sheep and a goat, but in tropical climates, the varieties of sheep and goats are not only extremely numerous but they pass into one another by insensible gradations. Table I. (*see* pp. 424 and 425) shows the number of live-stock in the meat-trade world at different dates. This and other Tables in this chapter have been compiled from the figures given with the evidence taken before the Departmental Committee on Combinations in the Meat Trades; similar data may also be found in the Annual Agricultural Statistics.

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* We are indebted to an able article on "The Meat-Supply of the United Kingdom," by Mr. R. H. Hooker, M.A., read before the Royal Statistical Society, May 18, 1909, for much of the information in this chapter, as also for the use of some of the diagrams.

We are also indebted to Messrs. Weddell and Company, of St. Helen's Place, London, E.C., for considerable assistance relative to the data, and for their kind permission to use the statistical chart which appears at the end of this chapter. AUTHORS.

TABLE I.: NUMBER OF LIVE-STOCK IN THE MEAT-TRADE WORLD AT DIFFERENT DATES

[In millions, to one place of decimals]

Country.	CATTLE.				SHEEP.				POPULATION in Millions.	
	About 1880.	About 1890.	About 1900.	About 1907–8.	About 1880.	About 1890.	About 1900.	About 1907–8.	About 1880.	About 1907–8.
United Kingdom	9.8	10.7	11.4	11.7	30.2	31.6	31.0	30.0	35.0	43.9
France	11.4	13.6	14.5	14.0	22.5	21.7	20.2	17.5	37.3	39.3
Algeria	1.2	1.2	1.1	1.1	8.0	8.9	8.0	8.8	3.3	5.2
Belgium	1.4	1.4	1.6	1.8	0.4	0.2	0.2	0.1	5.5	7.2
Luxemburg	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.2
Holland	1.5	1.5	1.7	1.8	0.8	0.8	0.8	0.5	4.0	5.8
Denmark	1.5	1.6	1.8	2.0	1.5	1.2	1.0	0.7	2.0	2.6
Norway	1.0	1.0	1.0	1.0	1.6	1.4	1.0	0.9	1.9	2.3
Sweden	2.2	2.4	2.6	2.6	1.5	1.4	1.3	1.0	4.6	5.4
Russia in Europe	30.0	30.6	39.4	36.6	60.0*	58.0*	61.2*	46.6*	83.5	118.4
Finland	1.1	1.2	1.4	1.5	1.0	1.0	1.0	0.9	2.1	2.9
Asiatic Russia	2.5	3.0	4.2	5.7	8.5*	9.0*	9.4*	11.9*	14.0	28.3
Germany	15.6	17.5	18.9	20.6	19.2	13.6	9.7	7.7	45.2	62.0
Austria	8.6	8.6	9.5	10.0	3.8	3.2	2.6	2.3	22.1	28.2
Hungary	5.3	5.8	7.0	7.5	9.8	10.0	8.7	7.0	15.6	20.5
Roumania	2.3	2.5	2.6	2.6	4.5	5.0	5.7	6.0	4.8	6.8
Bulgaria	1.6	1.7	2.0	2.2	6.7	6.8	7.0	7.0	2.0	4.2
Servia	0.8	0.8	1.0	0.9	3.0	3.0	3.1	3.1	1.7	2.8
Switzerland	1.2	1.2	1.3	1.5	0.4	0.3	0.2	0.2	2.8	3.5
Italy	4.7	5.0	5.5	6.2	8.6	6.9	8.0	11.2	28.5	33.9
Spain	2.5	2.2	2.3	2.4	18.0	13.4	13.5	13.7	16.6	19.2
Portugal	0.6	0.6	0.7	0.7	3.0	3.0	3.0	3.0	4.1	5.2
Total Europe	106.9	114.2	131.6	134.5	213.0	200.4	196.6	180.1	336.8	447.8

British North America	3.6	4.1	5.6	7.7	2.7	2.6	2.5	2.8	4.5	6.0
United States	46.0	66.2	67.8	71.3	58.6	56.7	61.6	54.6	50.2	86.3
Mexico	5.0	5.0	5.1	5.2	3.0	3.0	3.4	3.5	10.2	13.6
Total North America	54.6	75.3	78.5	84.2	64.3	62.3	67.5	60.7	64.9	105.9
Queensland	3.2	5.6	4.1	3.9	6.9	14.5	10.3	16.7	0.2	0.5
New South Wales	2.6	1.9	2.0	2.7	35.4	56.0	40.0	44.5	0.8	1.6
Victoria	1.3	1.8	1.6	1.8	10.4	12.7	10.8	14.1	0.9	1.2
Tasmania	0.1	0.2	0.2	0.2	1.8	1.6	1.7	1.7	0.1	0.2
South Australia	0.3	0.4	0.2	0.3	6.5	7.0	5.2	6.8	0.3	0.4
West Australia	0.1	0.1	0.3	0.8	1.2	2.5	2.4	3.7	0.0	0.3
Australia, total	7.6	10.0	8.4	9.7	62.2	94.3	70.4	87.5	2.3	4.2
New Zealand	0.7	0.8	1.3	1.8	13.0	16.2	19.3	22.4	0.5	0.9
Cape Colony	1.4	1.5	1.1	2.0	12.5	16.7	12.0	15.0	0.8	2.5
Natal	0.5	0.7	0.4	0.8	0.4	0.9	0.6	0.8	0.4	1.2
Uruguay	5.5	5.5	6.8	6.5	15.0	17.0	17.2	14.0	0.4	1.1
Argentina	14.0	22.0	23.0	29.1	70.0	71.0	76.0	67.2	2.5	5.7
Chile	0.8	0.8	0.8	0.8	1.3	1.3	1.3	1.3	2.5	3.4
Falkland Islands	0.0	0.0	0.0	0.0	0.4	0.7	0.8	0.7	0.0	0.0
Total Southern Hemisphere	30.5	41.3	41.8	50.7	174.8	218.1	197.6	208.9	9.4	19.0
Grand Total	192.0	230.8	251.9	269.4	452.1	480.8	461.7	449.7	411.1	572.7

* Including goats

Cattle in the United Kingdom. The number of cattle in the United Kingdom shows, on the whole, an increase during the past thirty years —from about 9.8 millions in 1877 to 11.6 millions in 1908. It may be observed, however, that the increase was nearly all in the first half of the period, the total reaching 11.5 millions in 1892, after which there was a drop of three-quarters of a million head in two years. Since then it has slowly risen again and the latest number is a record. That the number has increased only half as fast since 1895 as previously, may be safely attributed to the general decline of the farming industry, and to the gradual encroachment of towns and industrial concerns upon the agricultural land. It is not without interest to observe that, whereas in 1877 one head of cattle was kept for every 4.85 acres of the " area under crops and grass," the corresponding number was one for every 4.16 acres in 1892, one for every 4.45 acres in 1895, and one for every 4.00 acres in 1908.

The United States. Here we are in difficulties. This country undoubtedly has the largest stock of cattle in the world (except, perhaps, India) ; but comparisons with earlier periods are only to be made with great caution. The figures issued annually by the Department of Agriculture underwent a careful scrutiny, and were completely revised, in 1906–7, with the result of an addition to the nominal herds of some ten million head—not for the first time, as similar revisions at earlier dates resulted in additions of several millions to the stock as returned in immediately preceding years ; notably in 1901, when the number was given as 18,400,000 (or 42 per cent) more than in 1900. The latest revision puts the number in 1907 at 72,534,000, and it is stated that this figure is not comparable with earlier years. This number is made up of 20,968,000 " milch cows " and 51,566,000 " other cattle," which are stated to be 102.4 and 98 per cent. respectively of the numbers in 1906. This enables us to estimate the number in 1906 at 73,100,000. As the number returned in 1908 (January 1) is 71,300,000, this points to a decline of 1,800,000 head in the two years, made up of an increase of some 700,000 cows and a decrease of 2,500,000 other cattle. These latter, of course, include the beef cattle, and all that can be said is that such a decline is compatible with the known shortage of beef cattle in the United States in the last two or three years, which has so restricted imports thence and enhanced prices here. Apart from 1906-7, the chief revisions of the Department appear to have been made as the result of the publication of the numbers ascertained at the enumerations in connection with the decennial census ; the latter figures are taken (except, of course, for 1908).

The census figures, however, are not themselves comparable, inasmuch as the census of 1900 included spring calves, a procedure which was adopted in only a few instances in the enumerations of 1880 and 1890. Of the number enumerated in 1900, however, 15,333,000 were " calves under one year," leaving 52,489,000 as the number of cattle, excluding calves. Again, the 1900 Census Report estimates that at least 10 per cent., and possibly 20 per cent. of the "other cattle" (*i.e.* not milch cows) in 1890 were calves under one year old. Assuming 15 per cent., this brings the total of cattle, excluding calves, down to about 52,589,000 head. On the other hand, the census of 1890 enumerated cattle on ranches separately from those on farms, and calves *may* have been included in the former. Assuming that this is so, and assuming again that the proportion of calves on farms in 1890 to other cattle was the same as in 1900, we get 13,520,000 as the calves on farms in 1890, whence the grand total (including ranch cattle) works out at 66,110,000; or, allowing for calves probably omitted among the ranch cattle, say, 66,500,000. There are other complications, and this figure cannot be regarded as nearly accurate; the limit of error might be as much as 3,000,000 on either side. But it is obviously a better figure for comparative purposes than the 52,800,000 enumerated at the census of 1890. A similar calculation for 1880 shows 46,000,000 head, subject to a similar margin of error.

The absence of trustworthy data regarding the chief source of our beef-supply is singularly unfortunate, and we are really not in a position to trace, with any degree of certitude, the course of events in the past, or, consequently, to judge adequately whether the United States can continue to supply us at the same rate as hitherto. The effect of the calculation is to indicate that whereas between 1880 and 1900 cattle increased more rapidly than population (about 70 per cent. as compared with some 50 per cent.), the reverse has held since, although as shown by the course of trade, the surplus available for export still continued to increase for some time. But when will this surplus cease to increase? The statistics really do not supply a definite answer.

A time may come, and it seems to be fairly certain that it will come, when the United States will, like other countries, be "fully" stocked with cattle.

Argentina, Australia, and New Zealand. Possibly, next in importance to the United States is Argentina. Enumerations have been made at rare intervals, but these indicate that the number tends to increase fairly steadily; the total at the latest census in 1908 (29,100,000) being greater by 4,100,000 than at the previous census in 1895.

The live-stock of Australia is peculiarly susceptible to the ravages caused by drought, and its history of cattle-raising, like that of sheep, seems to consist in alternations or decimation of the herds, followed by gradual reconstruction. It may possibly surprise some readers to learn that the chief cattle state is Queensland, though some of its prominence has recently departed. The culminating year for Queensland (and Australia) was 1894, when it possessed 7,000,000 head out of a total of 12,000,000 on the continent. From this the number declined rapidly until a minimum of just under 2,500,000—practically the same figure as in 1878—was reached in 1903, out of perhaps 6,800,000. In common with the other states, Queensland has since greatly increased its herds, and Australia has now some 10,000,000 head.

New Zealand, less subject to climatic vicissitudes, shows practically steady progress, and there are now some 1,800,000 head in that island.

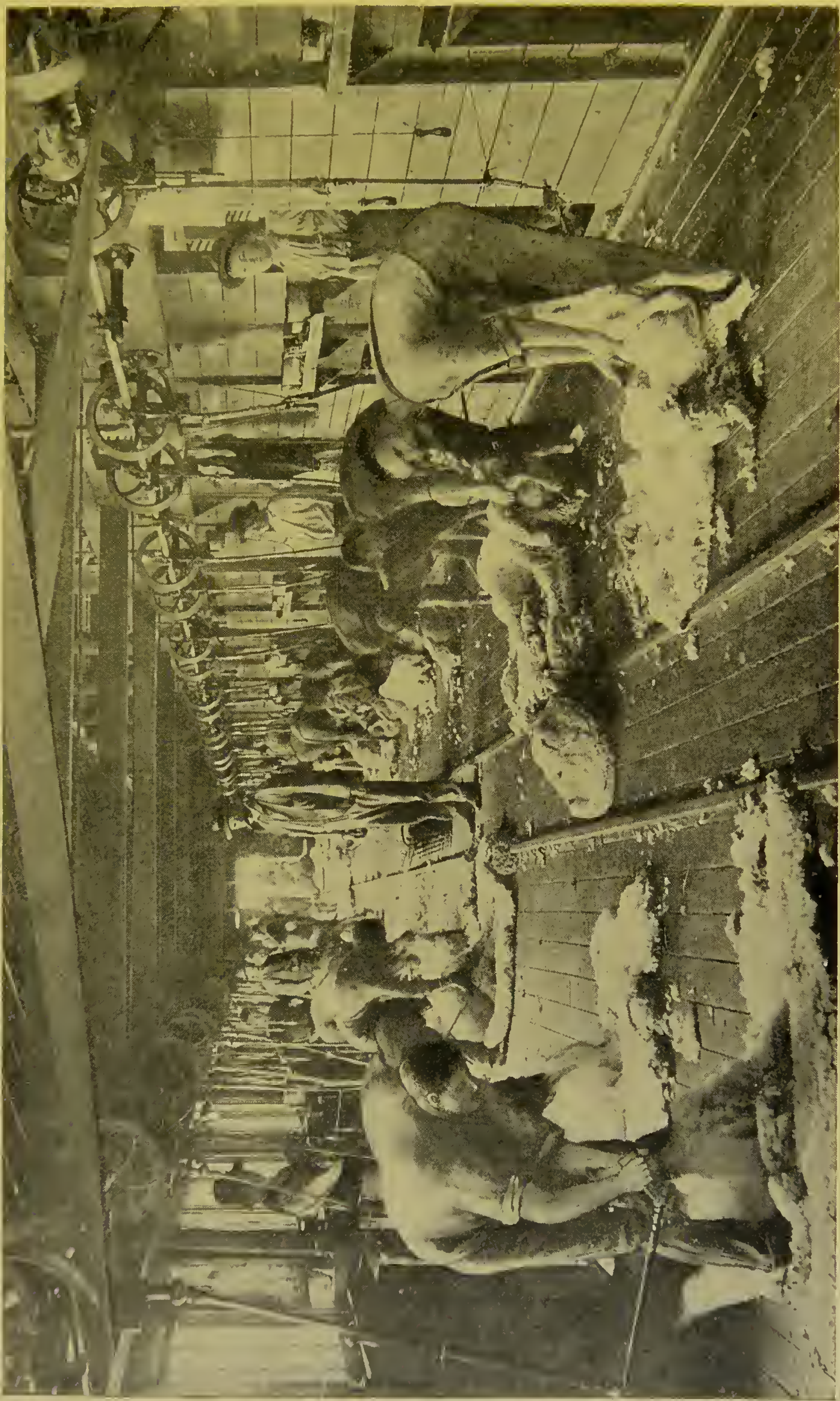
European Countries. *Russia* has the largest stock of any country after the United States. Statistics are available only since 1900 for the Empire as a whole: they show the total to have fluctuated between 40,000,000 and 45,000,000, and there is not much evidence of increase in the past decade, in spite of the progress of her Asiatic territories. The future of Russia as a possible purveyor of meat is quite an unknown quantity. Suggestions for developing the export trade are frequently heard, but there are many other ways in which the vast areas at present unutilised, particularly in Asia, may be rendered profitable. *France* exhibits a condition somewhat similar to our own; there have been throughout some 2,000,000 to 3,000,000 head more than in the United Kingdom—rather more in 1900–2, in which latter year the figure almost touched 15,000,000; since when the stock has diminished by 1,000,000. *Germany* and *Belgium*—both meat-importing countries—show steady progress on the whole, not disproportionate to the population, as does *Denmark*. Other countries do not call for special comment.

THE SHEEP INDUSTRY

It may be said that the great feature of the past thirty years has been the steady, and indeed rapid, approach to extinction of the flocks of sheep in Europe. This is probably in part due to the quick extension and severe competition, during the first part of the period, of the Southern Hemisphere. Since the early 'nineties, however, this has received a notable check, and it can hardly be said that any country in the world is at present developing its sheep industry. The decline in the world's sheep stock since 1890 must be something like 7 per cent.

Decline in the United Kingdom. The decline here is much less than in any country of Central Europe. In 1877 our flocks numbered 32,220,000 and reached a maximum of 33,600,000 in 1892. Since then there has been a gradual decline to 29,000,000 in 1904 and 1905, followed by an increase of a couple of million since—due, no doubt, to the high prices of wool in 1906–7. Generally speaking, however, the comparative maintenance of our sheep stock may probably be ascribed to the continual conversion of arable land to permanent grass which has been so marked a feature since the fall in corn prices in 1875–95. Sheep fluctuate considerably in numbers, and seem much affected by climate, or diseases consequent thereon; the drop of over 4,000,000 between 1879 and 1882 was caused by the very wet summer of 1879, which resulted in great losses from liver-fluke.

Australia's Rapid Development. The statement above, that no country seems now to be developing its sheep-farming industry, is apparently contradicted by this continent, which has gained 15,000,000 to 20,000,000 head since 1900. But this is a revival, and the present total—probably not much short of 90,000,000—is not yet equal to that



The Sheep Industry in the Colonies: Inside View of a Shearing-house

There are vast numbers of sheep grown in our Colonies, and the illustration shows that at shearing time much employment is given in this respect, mechanical shears being extensively used.

of the early 'nineties. The history of sheep in Australia is, in fact, intimately bound up with climatic cataclysms in the shape of prolonged droughts which ravage the flocks, they being followed by years of normal or abundant rainfall, during which the flocks are built up again. To take New South Wales, for example, which possesses more than half the Australian total, there was rapid progress from 21,500,000 in 1877 to nearly 62,000,000 in 1892 (with only one bad check in 1884). Then came the lean years, and the numbers fell away steadily, with slight exceptions, but including drops of 9,000,000 between 1894 and 1895, and of no less than 15,000,000 between 1901 and 1902, when there remained no more than 26,000,000. At this period the Australian total must have been far below the Argentine. This proved the nadir, and the number has since been more than doubled. Queensland shows similar vicissitudes; Victoria and South Australia suffer rather less violently. The absolute maximum total for Australia was 105,400,000 in 1891, the absolute minimum (since 1878) probably exactly half of this, in 1902 or 1903. Although the numbers in the last six years have therefore shown steady and satisfactory increase, yet it is impossible to say that disastrous droughts will not recur to wipe out the flocks; and it appears probable that some 100,000,000 to 120,000,000 sheep will prove Australia's maximum for many years to come, unless the return of a bad drought is postponed.

New Zealand does not suffer like Australia from drought; this colony shows steady, though not over-rapid, development—not so rapid as in cattle. Conceivably this may be due to so many exporters of meat from New Zealand making a speciality of sending over lamb instead of the full-grown mutton.

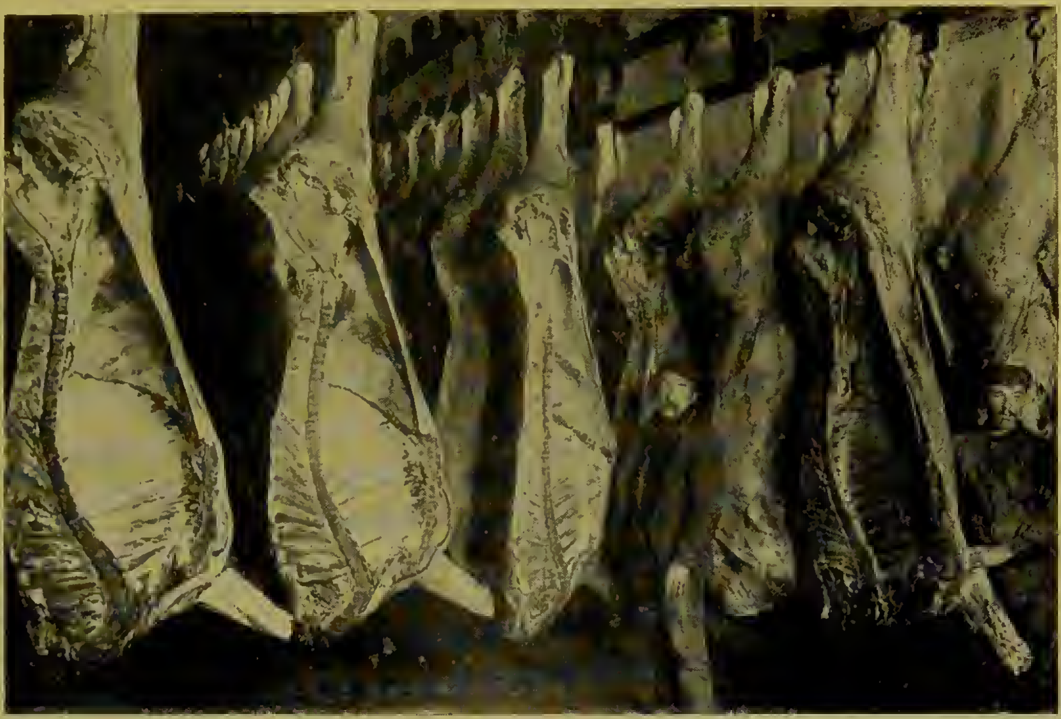
Argentina. This, after Australia, is the most important sheep country in the world. The rise in numbers was in earlier years rapid, and 74,400,000 was attained in 1895. No further enumeration has been made until 1908, revealing a total of 67,200,000 only, which appears to indicate that the high-water mark has been passed.

Uruguay is important (for its size it has also a large cattle industry). The number of sheep appears to have risen from 11,000,000 in 1892 to 18,600,000 in 1900; but there would seem to have been a decline since, to something like 14,000,000.

South Africa. This practically completes the southern hemisphere. The chief district is Cape Colony, where sheep appear to have reached a maximum about 1891-93, when it had little short of 17,000,000, though by 1899 this had fallen to 12,600,000. In the following troublous years no statistics were collected, but a rapid rise from 11,800,000 to 17,150,000 is recorded between 1904 and 1907. (It is not certain that these figures apply to the same area.) Paucity of comparable data compels the omission of the *Transvaal* and *Orange River Colony*: the latest data (about 1905) show 4,194,000 in the latter, and 847,000 in the former.

United States. Differences in the method of collection make it just as difficult as in the case of cattle to say what is the state of affairs here;

and the general remarks made in discussing the cattle statistics apply equally to the sheep. It would appear probable that the industry is more or less stationary. It may be that the high-water mark has already been passed, although some of the States have still considerable areas available for sheep. In compiling the figures, spring lambs were, theoretically, excluded in 1880 and 1890, but the United States Census Report of 1900 considers it "probable that not more than 10 per cent. of the sheep enumerated" previous to that year were lambs. The number enumerated in 1890 was 40,876,000; hence, deducting 10 per cent., we get 36,789,000 as the number, excluding lambs. Assuming again the same proportion of lambs as in 1900, when 21,668,000 were recorded as against 39,938,000 of other ages, we find 19,960,000 lambs, giving. 56,700,000 as a very rough approximation to the number in 1890. A similar calculation gives 58,600,000 for 1880. A decline of 1,500,000 is recorded in the Department of Agriculture's figures between 1908 and 1909.



Chill-room in Meat Export Works, Queensland

The greatest care is exercised in export meat factories, to see that all meat is properly and slowly chilled, before being put on board ship for export.

In the **Old World** *Spain*, once so famous for its wool, would appear to be stationary with 13,000,000 to 14,000,000; but enumerations are so rare that it is difficult to be sure, and the same remark applies to *Italy*. The largest number of sheep in the Old World is to be found in the *Russian Empire*, which exhibits a decline from 71,500,000 in 1900 to 57,500,000 in 1908. As with cattle, however, the vast Asiatic areas (where the number is steadily increasing) render it unsafe to say that this Empire may not again increase its flocks. The most startling decline in Europe is, however, that in *Germany*, whose 19,000,000 sheep of 1883 were in 1908 reduced to 7,700,000. In *Belgium* also the industry has dwindled to such an extent that sheep are no longer distinguished in the live-stock returns. *France* tends to resemble more the United Kingdom in showing but a slow decline, although it is more persistent and accentuated than here, since it amounts to a loss of 5,000,000 head, or not quite 20 per cent., in the past thirty years.

In the last two columns of Table I. (*see* pages 424 and 425) are added the approximate populations at the commencement and end of the period. During the first decade, the world's meat-supply probably increased at a distinctly faster rate than population ; in the second, perhaps not quite so fast ; but since 1900, population has very decidedly increased much faster than the meat stock. This is not incompatible with our having more meat to eat, because thirty years ago there must have been great waste, and much live-stock was never converted into meat at all. But the margin between the amount of meat actually delivered from the farm animals of the world, and the potential supply shown in these estimates must have considerably diminished in the last decade. The total meat-supplies of the United Kingdom for ten years (1898–99 to 1907–8) were estimated by the Board of Agriculture and Fisheries as per Table II.

TABLE II.

Years.	All Meat.		
	Home.	Foreign.*	Total.
	Cwt.	Cwt.	Cwt.
1898–9 . .	23,704,740	19,397,420	43,102,160
1899–1900 .	26,062,660	20,266,320	46,328,980
1900–1 . .	25,200,980	20,935,840	46,136,820
1901–2 . .	25,174,840	20,488,100	45,662,940
1902–3 . .	24,448,080	18,745,360	43,193,440
1903–4 . .	24,904,420	20,594,520	45,498,940
1904–5 . .	25,833,200	20,789,000	46,622,200
1905–6 . .	24,870,720	21,842,900	46,713,620
1906–7 . .	24,835,260	21,364,720	46,199,980
1907–8 . .	25,313,020	21,537,360	46,850,380

It is apparent that with the Home Supply remaining practically stationary, the increasing demand from the larger population has been met from foreign and colonial sources. The importation of live animals, however, has dwindled in the case of sheep and lambs from about 1,000,000 to 78,900, and, in recent years, the imports of cattle have also diminished. This decline is due, in large part, to the orders issued by the Board of Agriculture and Fisheries under the provisions of the Diseases of Animals Acts, but is mainly due to changes in trade methods.

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* Including " Meat, unenumerated " and less exports of dead meat (British and Foreign).

The following Table III. gives the average animal importations for seven quinquennial periods and for the four years 1905 to 1908.

TABLE III.

Period.	Cattle.	Sheep and Lambs.
Average 1870–74 .	206,331	801,367
,, 1875–79 .	247,979	947,610
,, 1880–84 .	390,611	1,012,363
,, 1885–89 .	384,194	879,085
,, 1890–94 .	493,545	265,858
,, 1895–99 .	533,802	743,614
,, 1900–4 .	496,569	359,222
1905 . . .	565,139	183,084
1906 . . .	561,215	103,359
1907 . . .	472,015	105,601
1908 . . .	383,130	78,900

The orders issued by the Board of Agriculture and Fisheries already referred to, have had the effect of gradually prohibiting the importation of live animals from any countries except the United States, Canada and Iceland. Cattle and sheep from Canada frequently come through the United States ports and occasionally the reverse process takes place.

Table IV. shows the supplies of live cattle and sheep actually consigned from the United States and Canada during the years 1904–8.

TABLE IV.

Year.	Cattle.		Sheep.	
	United States.	Canada.	United States.	Canada.
1904 . . .	390,672	157,176	271,437	101,202
1905 . . .	399,440	164,184	136,092	42,244
1906 . . .	384,834	174,742	69,009	29,471
1907 . . .	351,186	119,028	67,860	35,209
1908 . . .	259,700	122,086	46,000	30,385

In regard to *cattle*, it may be pointed out that Canadian cattle, though, as is apparent from the above Table, they are imported in large numbers for slaughter, have not yet reached a very high standard of quality; and the inducements to ship from the United States are not so great as they were formerly, partly because it is very much cheaper to ship dead meat than live cattle, and partly, perhaps, because the American firms engaged in this business find it more profitable to utilise the hides, offal, &c., for manufacturing purposes in the United States, rather than to dispose of them in the United Kingdom.

The invention of meat-freezing and chilling apparatus enabled new trade methods to be applied, and the importation of live animals has gradually been giving way to the chilled carcase. In the two years 1889 and 1890 the beef imports from the United States abruptly raised themselves and maintained high figures until 1908. American beef is chilled, and a large proportion of Argentine beef is also chilled, but the distance from Australia and New Zealand makes freezing necessary. Recently, however, some successful experiments have been made in introducing Australasian meat to the United Kingdom in the chilled condition.

Table V. shows the rapid strides which the Argentine Republic has made in the meat business and how it has really taken first place in the source of supply.

TABLE V.

Period.	Total * Imports.	Imports from Principal Countries.			
		United States.	Argentine Republic.	New Zealand.	Australia.
	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Average 1870–74	29,839	1,095†	—	—	—
,, 1875–79	350,733	326,664	—	—	—
,, 1880–84	738,357	692,289	500‡	2,138§	
,, 1885–89	917,685	864,154	4,056	28,765	8,744
,, 1890–94	1,953,379	1,731,620	14,478	55,059	126,498
,, 1895–99	2,952,968	2,204,919	83,362	69,146	536,504
,, 1900–4	4,170,780	2,685,550	987,084	222,178	175,440
1905 . .	5,037,521	2,232,206	2,580,152	145,338	19,025
1906 . .	5,523,809	2,426,644	2,795,913	236,587	34,457
1907 . .	5,735,003	2,417,604	2,691,554	391,299	126,030
1908 . .	5,631,989	1,432,142	3,590,307	347,872	112,583

American chilled beef has often commanded high prices on British markets.

Salted and other preserved meat is imported in fair quantities, but these have shown a marked falling-off in the last few years. Thus, as regards salted beef, which comes mainly from the United States, the average annual supply for the years 1890–94 was 248,141 cwt.; for 1900–4 it was 173,780 cwt.; and for the following four years the amounts were, 1905, 142,806 cwt.; 1906, 161,363 cwt.; 1907, 138,347 cwt.; and 1908, 114,742 cwt. The imports of beef, preserved otherwise than by salting, have varied considerably, the average annual amounts being: 1890–4, 470,022 cwt.; 1895–99, 378,615 cwt.; 1900–4, 518,143 cwt.; a maximum of 598,030 cwt. was reached in 1905, and was followed by a sharp drop to 160,386 cwt. in 1907, with a recovery to 270,841 cwt. in 1908. The bulk of the supply comes normally from the United States, but there was a considerable importation from Argentina and Australia.

* Including a small quantity of untreated meat. † 1874 only.
‡ 1884 only. § New Zealand and Australia, average for 1883 and 1884.

As regards *mutton*, there was an importation amounting to 267,222 cwt. in 1908 from Holland, and very small amounts from other European countries and the United States. The great bulk of the imports comes from New Zealand, the Argentine Republic and Australia. The expansion of the import trade is shown in the following Table, which gives the average annual imports for certain periods since 1882 (the first year for which mutton was separately distinguished) and also the amounts for the four latest years :

TABLE VI. : IMPORTS OF FROZEN MUTTON,* 1882–1908

Period.	Total Imports.	Imports from Principal Countries.		
		New Zealand.	Argentine Republic.	Australia.
	Cwt.	Cwt.	Cwt.	Cwt.
Average 1882–84 .	309,846	106,123	21,900†	42,242
,, 1885–89 .	844,499	418,669	258,920	44,064
,, 1890–94 .	1,857,189	864,098	488,782	248,894
,, 1895–99 .	3,091,978	1,268,566	934,612	625,183
,, 1900–4 .	3,634,416	1,654,556	1,329,423	317,621
1905 . . .	3,811,069	1,524,981	1,462,537	505,413
1906 . . .	4,082,756	1,748,188	1,433,097	616,870
1907 . . .	4,578,523	2,005,078	1,402,302	858,226
1908 . . .	4,391,259	1,737,606	1,556,746	636,034

It will be seen from this Table that, in spite of a set-back in 1908, New Zealand is the largest provider of the United Kingdom market, but is beginning to be closely pressed by the Argentine Republic ; whilst, as in the case of beef, the Australian supplies fluctuate greatly. There is a small importation of preserved mutton, chiefly from Australia.

In competing for the frozen mutton trade, *New Zealand*, with a population of less than a million human beings, is at the greatest disadvantage. The colony is farthest away from Smithfield Market, yet is able to compete successfully for a share in the over-sea supplies of food for the United Kingdom. New Zealand possesses over 20,000,000 sheep and 2,000,000 cattle, and the surplus after providing for their own wants is sent to Great Britain, most of it to the Port of London, to a total value of something like £4,000,000 per annum.

In working this gigantic business, co-operation among the flock-masters and aid from their Government are the principal factors. The latter is given in the form of technical instruction, close inspection, strict sanitary regulations and favourable railway and harbour arrangements.

The New Zealand farmer has learned that other countries can beat him on a question of cheapness, but he refuses to accept any suggestion that he can be beaten on quality. All the meat shipped to the United Kingdom is therefore the best of its kind. The flocks of New Zealand are reared in a first-class climate, and disease is consequently not greatly in evidence; whenever it does appear it is easily stamped out. The twenty-four large slaughtering and freezing works through which all the exported meat of the colony passes are conducted on strictly hygienic lines, while the Government's inspection law is one of the most drastic in the world. The flocks and herds are periodically inspected, and all animals found to be diseased are speedily condemned and compensation to the extent of half their value paid to the owners.

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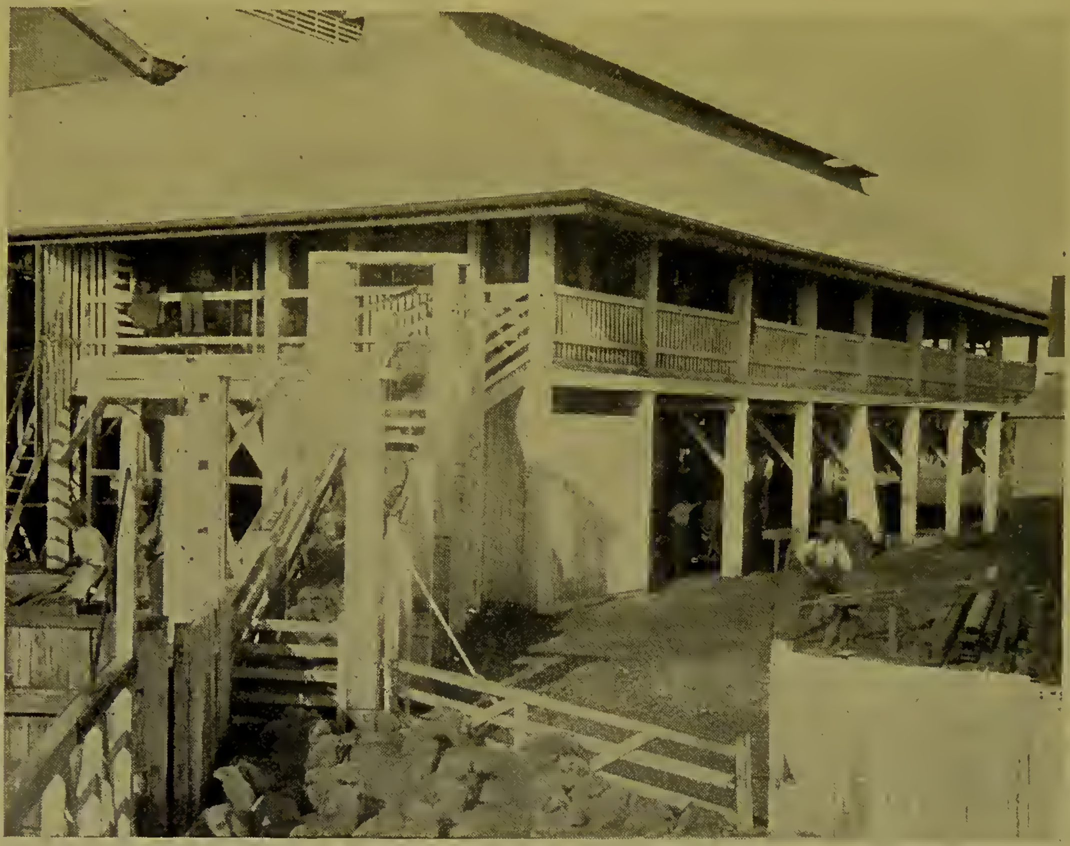
* Including a small quantity of chilled and untreated mutton.

† Average for 1883 and 1884 only.

Meat slaughtered for export must be killed in the licensed slaughter-yards of the frozen-meat companies, attached to which are inspectors holding the certificate of the English Royal College of Veterinary Surgeons. Further inspection takes place at the port of shipment, where the State inspectors have power to reject any carcases not up to the standard for export.



Slaughterhouse, showing Sheep Race, in Meat-export Works, Queensland

In this illustration it is shown how the sheep are driven up a gangway to the abattoir overhead, thus allowing for gravitation in handling the by-products.

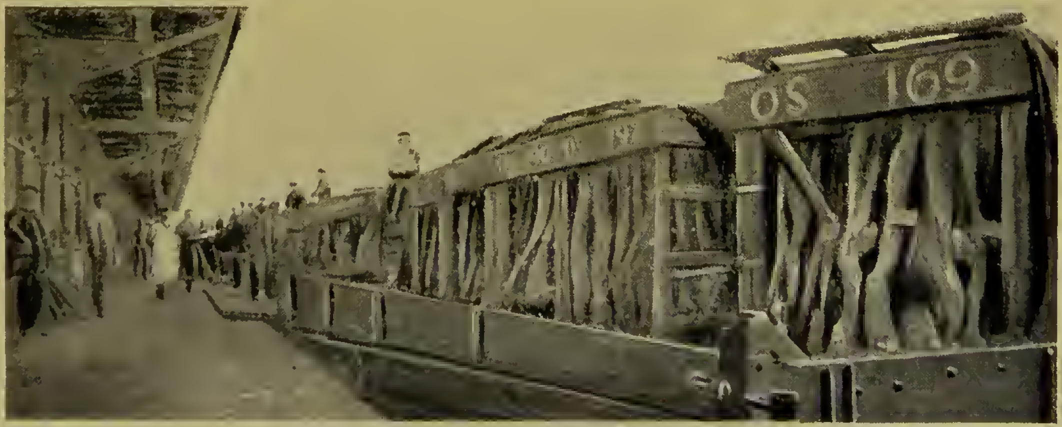
In the Australian Colonies each state specialises its meat exports: Queensland leads in beef, New South Wales in mutton, and Victoria in fat lambs. So far as experience goes, it looks as if lamb was pushing out mutton and taking second place with beef as the principal meat-food of the United Kingdom. Australian lambs fill the gap when New Zealand lambs are finished, and there is practically a continuous supply in the London market.

Loading Meat at Flushing, for Export

The value of the exports of frozen meat from the Australian Commonwealth is about a million and a half sterling, and this gigantic trade means that the States of the Commonwealth each pay great attention to the production of the highest quality possible.

The export of meat from Queensland has not expanded in recent years owing to the difficulty experienced by the meat-freezing establishments in obtaining cattle at prices which enable the killers to compete in the London market. Taking the Statistical Report of the Department of Agriculture of Queensland, it is found that the number of establishments dealing with the wholesale slaughter of live-stock has been reduced to eleven as against forty-seven in the year 1899. In 1907 there were 74,232 head of cattle dealt with at their factories, 68,483 being frozen, yielding 47,169,088 lb. of beef; while of 255,635 sheep slaughtered, 242,384 were frozen, yielding 9,796,205 lb. of mutton.

Since 1881, when the meat export trade started in New South Wales, the quantities shipped have varied greatly. The first year's shipments



A Dutch Train with Meat hanging in Crates

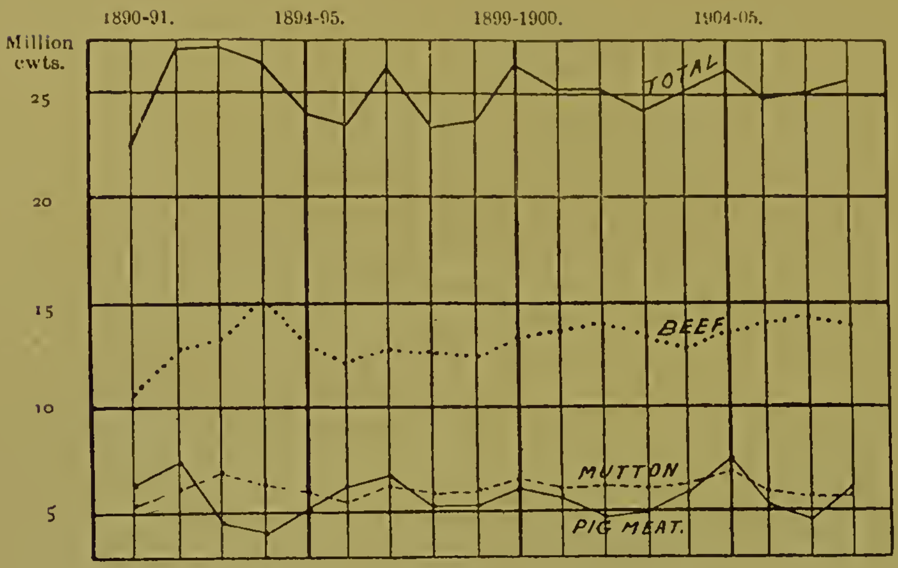


Diagram I.—Home Production of Meat

amounted to 9980 cwt. of a total value of £8554, and in the year 1905 the corresponding figures were 483,147 cwt. and £641,216.

In favourable seasons sheep increase rapidly, and with a succession of good seasons there is always a danger of over-stocking, but the colonists of Australia have worked up a splendid system of exporting their surplus stock, and the trade is now of vital importance to them. The pastoral industries of the Colonies found the open markets of Great Britain an outlet for everything they could profitably ship, and the necessity for getting quit of the surplus production compels the Colonial Governments to use every precaution to see that the trade is worked on strictly defined lines. The United Kingdom wants only their best quality, and it does not pay the Colonies to ship inferior quality.

The series of diagrams I. to IX. show the variations in imports of meat from the different countries compared with the home production.

In summarising the imports of meat into the United Kingdom, the grouping of the main divisions of the world may be continued on the lines of Table I., viz.: North America, consisting of the United States and British North America; Southern Hemisphere—including Argentina, Chili, Uruguay, Australia and New Zealand and Europe (including Algeria and Asiatic Russia). The course of trade from these three quarters of the globe is given in Table VII. and Diagram X.

From North America the trade rose steadily until a maximum was reached in 1901; from the Southern Hemisphere, which entered the arena in the late 'eighties, progress has been and still is rapid, though interrupted shortly after the commencement of the present century by Australian droughts; from Europe the trade has been, on the whole, nearly stagnant.

Beef is now arriving in about equal quantities from North America and the Southern Hemisphere, and mutton almost entirely from the Southern Hemisphere.

TABLE VII.: TOTAL IMPORTS OF (LIVE AND DEAD) MEAT INTO THE UNITED KINGDOM

[In thousands of cwt.]

Year.	Beef.				Mutton.			
	From North America.	From Southern Hemisphere	From Europe, &c.	From World.	From North America	From Southern Hemisphere	From Europe, &c.	From World.
1877	803	—	823	1,626	13	—	505	518
1878	1,329	—	652	2,081	48	—	479	527
1879	1,519	—	599	2,118	108	—	450	558
1880	2,451	2	793	3,246	83	—	475	558
1881	2,077	3	748	2,828	66	—	487	553
1882	1,223	2	1,236	2,461	103	37	713	853
1883	2,512	3	1,221	3,736	146	108	637	891
1884	2,446	5	975	3,426	85	353	622	1,060
1885	2,532	19	694	3,245	64	450	506	1,020
1886	2,215	29	671	2,815	66	575	638	1,279
1887	1,964	8	545	2,517	25	689	645	1,369
1888	2,437	45	730	3,212	36	885	645	1,566
1889	4,204	109	686	4,999	46	1,005	576	1,627
1890	6,014	191	495	6,700	36	1,416	496	1,948
1891	5,335	342	271	5,948	39	1,573	325	1,937
1892	6,055	341	38	6,434	14	1,521	280	1,815
1893	4,302	390	68	4,760	5	1,796	291	2,092
1894	5,477	439	28	5,944	216	2,175	292	2,683
1895	4,698	942	35	5,675	382	2,760	273	3,415
1896	5,962	1,107	12	7,081	196	2,973	284	3,453
1897	6,268	1,345	57	7,670	145	3,214	282	3,641
1898	5,886	1,396	56	7,338	108	3,407	297	3,812
1899	5,985	1,580	77	7,642	111	3,458	313	3,882
1900	6,401	1,580	101	8,082	109	3,211	354	3,674
1901	6,983	1,342	90	8,415	217	3,334	332	3,883
1902	5,581	1,385	204	7,170	200	3,344	361	3,905
1903	6,359	1,690	114	8,163	193	3,783	285	4,261
1904	6,425	2,108	84	8,617	215	3,240	285	3,740
1905	6,408	2,948	92	9,448	110	3,570	261	3,941
1906	6,418	3,178	22	9,618	58	3,877	253	4,188
1907	5,725	3,340	29	9,094	61	4,379	215	4,675
1908	4,160	4,271	43	8,474	49	4,155	289	4,493

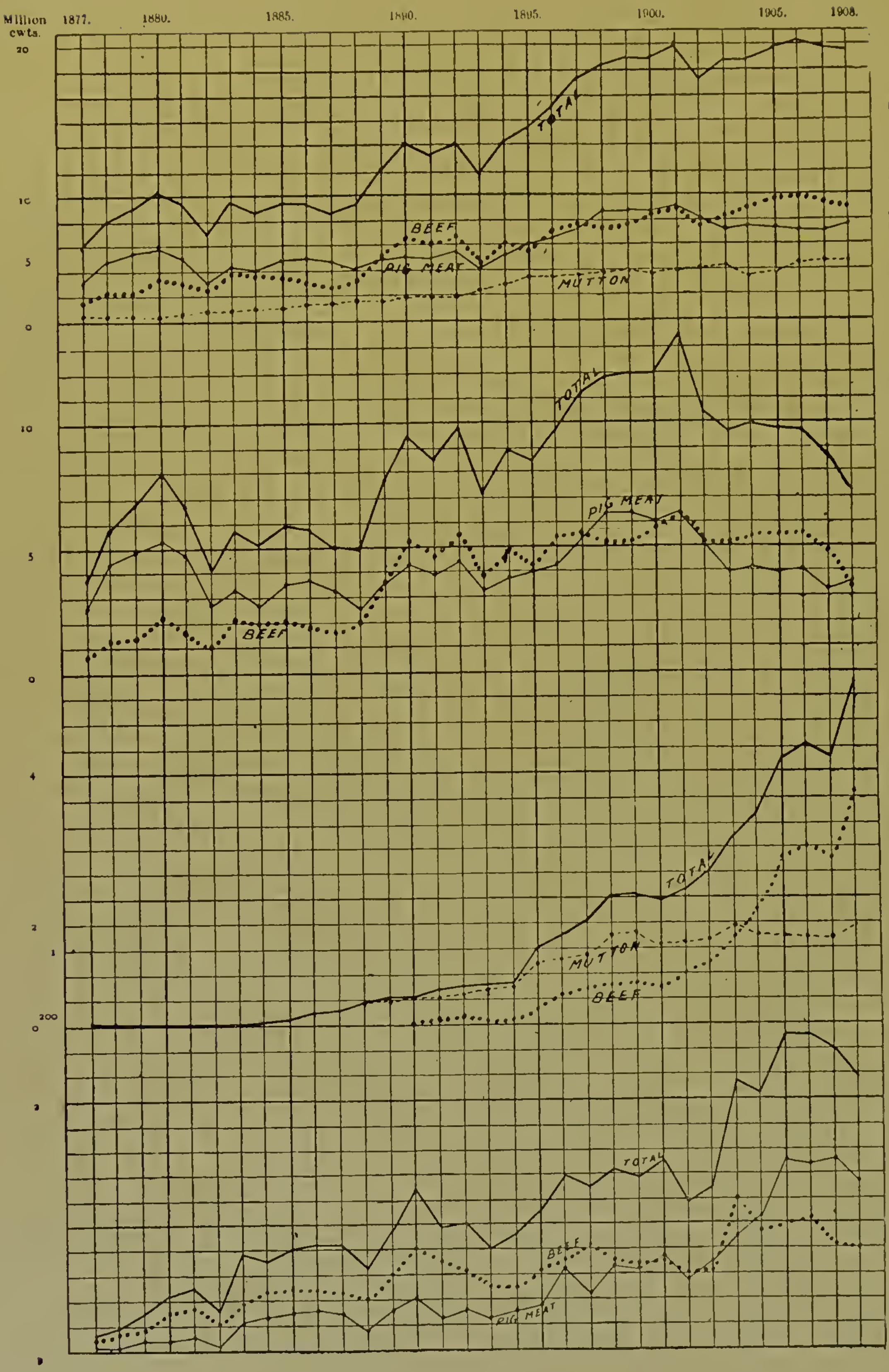


Diagram II.—Total Imports of Meat

Diagram III.—Imports from the United States

Diagram IV.—Imports from Argentina

Diagram V.—Imports from British North America

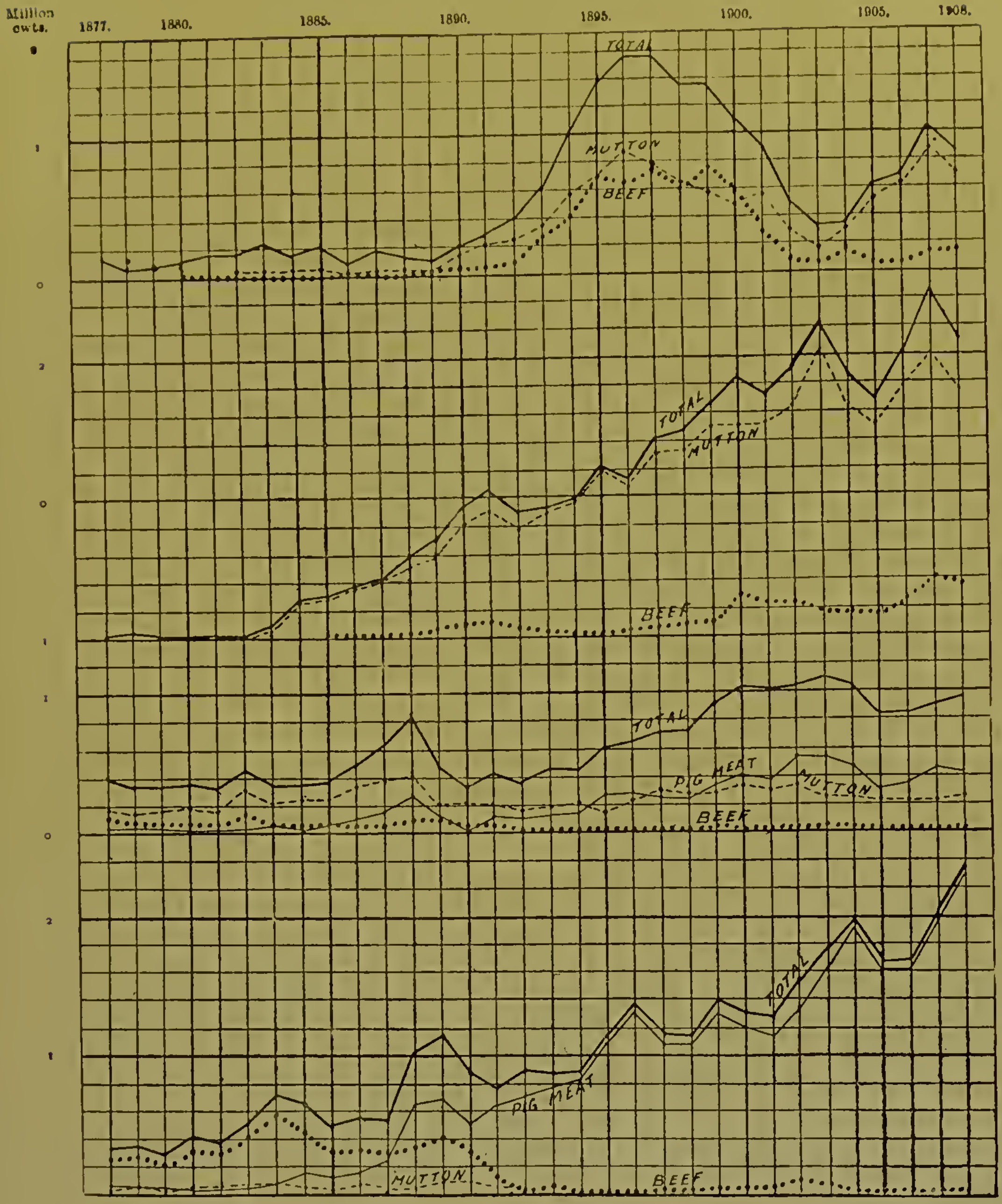


Diagram VI.—Imports from Australia

Diagram VII.—Imports from New Zealand

Diagram VIII. Imports from Holland

Diagram IX.—Imports from Denmark

The total meat consumed may be taken as the sum of that produced and that imported (less exports). Considering the period since 1890, we have the data shown in Table VIII. which are exhibited succinctly in the accompanying Diagram (XI.). Here it has been necessary, owing to the method of calculating the home production, to adopt the "meat year," and the imports are for the year June–May, the figures being taken from the monthly trade returns. The conversion of live into dead meat has, of course, been made in exactly the same way, and at the same rates, as the imports for calendar years.

The total consumption of beef (including veal) increased from about 18,000,000 cwts. in 1890–91 or thereby, to 22,844,000 in 1907–8.

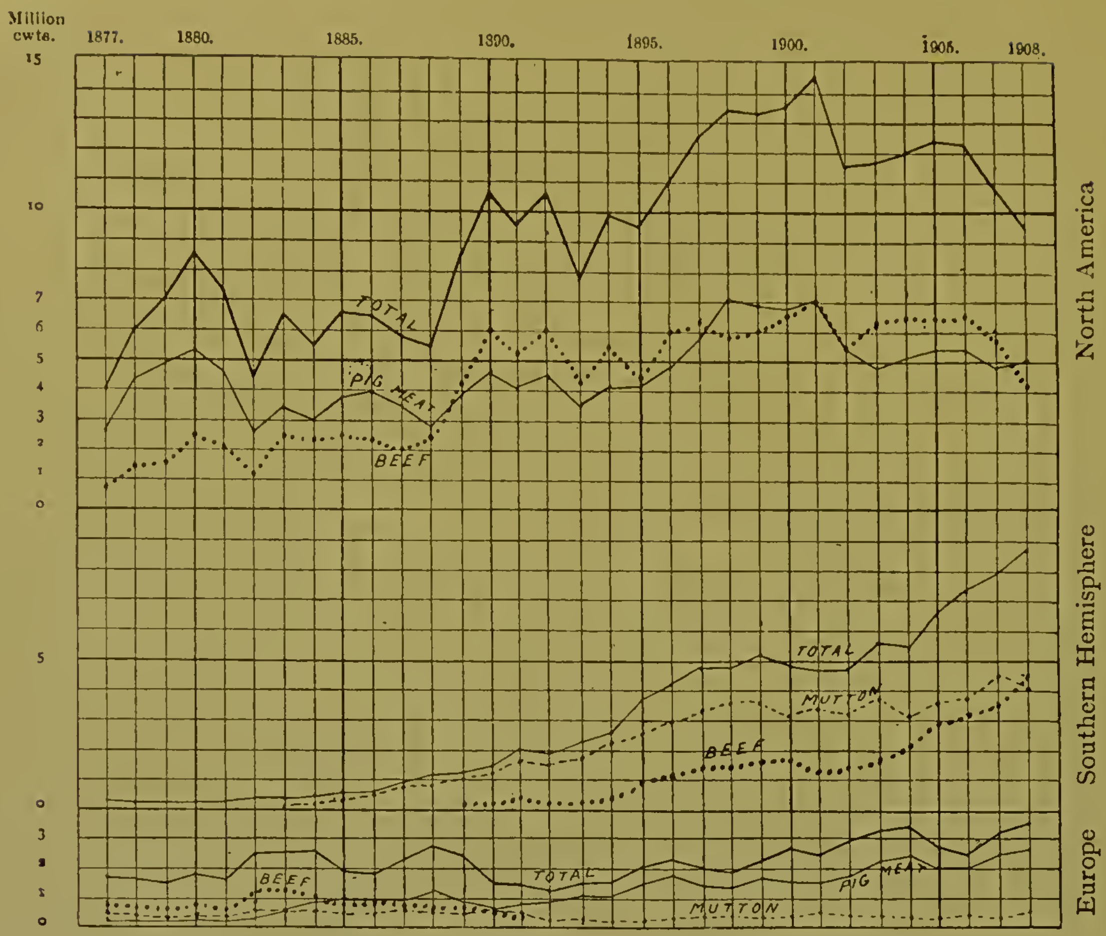


Diagram X.—Imports from Main Divisions of the World

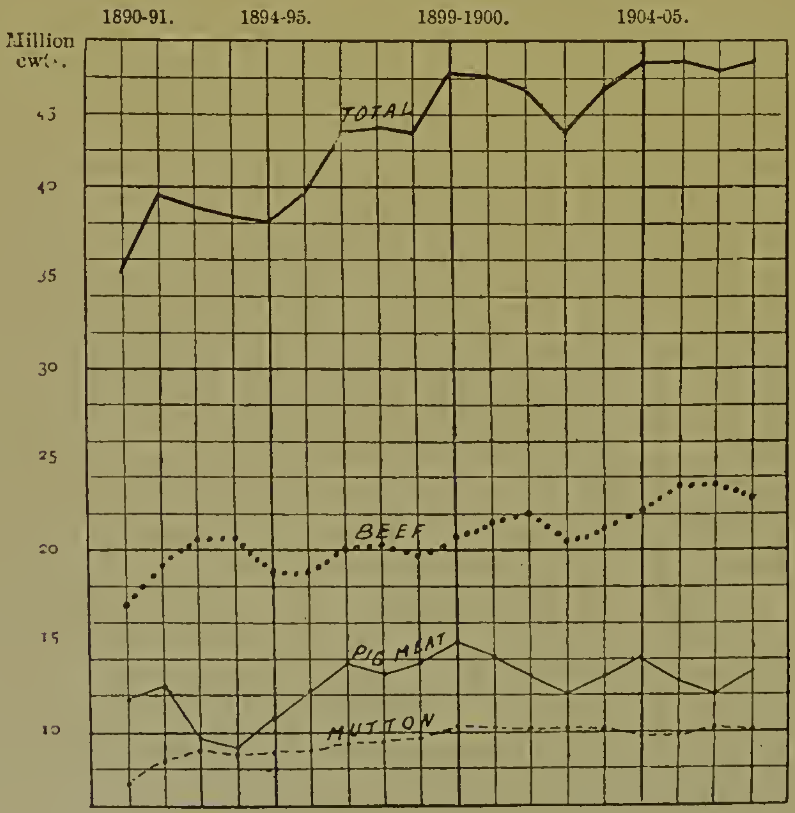


Diagram XI.—Consumption of Meat in United Kingdom

TABLE VIII.: ESTIMATED MEAT-SUPPLY OF THE UNITED KINGDOM

Years.	Beef and Veal.				Mutton and Lamb.			
	Home.	Foreign.	Total.	Per Cent. of Home to Total.	Home.	Foreign.	Total.	Per Cent. of Home to Total.
	Cwt.	Cwt.	Cwt.		Cwt.	Cwt.	Cwt.	
1890–91 .	10,648,360	6,309,020	16,957,380	62.8	5,530,520	1,881,850	7,412,370	74.6
1891–92 .	12,815,700	6,389,500	19,205,200	66.7	6,454,380	1,841,100	8,295,480	77.8
1892–93 .	14,926,960	5,677,470	20,604,430	72.4	7,062,840	2,026,290	9,089,130	77.7
1893–94 .	15,069,320	5,336,300	20,405,620	73.8	6,683,640	2,150,180	8,833,820	75.7
1894–95 .	13,045,460	5,639,840	18,685,300	69.8	5,888,400	3,057,460	8,945,860	65.8
1895–96 .	12,158,140	6,492,740	18,650,880	65.2	5,362,220	3,673,660	9,035,880	59.3
1896–97 .	12,769,940	7,093,320	19,863,260	64.3	6,131,740	3,321,240	9,452,980	64.9
1897–98 .	12,496,600	7,814,740	20,311,340	61.5	5,802,300	3,832,120	9,634,420	60.2
1898–99 .	12,448,380	7,206,860	19,655,240	63.3	5,988,600	3,792,840	9,781,440	61.2
1899–1900	13,156,500	7,877,360	21,033,860	62.5	6,607,820	3,837,240	10,445,060	63.3
1900–1 .	13,385,120	8,322,960	21,708,080	61.7	6,238,460	3,896,380	10,134,840	61.6
1901–2 .	13,943,980	8,014,400	21,958,380	63.5	6,422,240	3,698,620	10,120,860	63.5
1902–3 .	13,311,780	7,218,460	20,530,240	64.8	6,125,200	4,089,920	10,215,120	60.0
1903–4 .	12,772,460	8,669,680	21,442,140	59.6	6,188,360	3,966,080	10,154,440	60.9
1904–5 .	13,393,360	8,799,600	22,192,960	60.3	5,938,680	3,925,580	9,864,260	60.2
1905–6 .	13,792,980	9,813,340	23,606,320	58.4	5,910,780	4,014,820	9,925,600	59.6
1906–7 .	14,290,500	9,312,580	23,603,080	60.5	5,696,900	4,475,740	10,172,640	56.0
1907–8 .	13,886,360	8,958,880	22,845,240	60.8	5,635,560	4,452,420	10,087,980	55.9

TABLE VIII.—(*continued*)

Years.	Pig-meat.				Total.			
	Home.	Foreign.	Total.	Per Cent. of Home to Total.	Home	Foreign.*	Total.	Per Cent. of Home to Total.
	Cwt.	Cwt.	Cwt.		Cwt.	Cwt.	Cwt.	
1890–91	6,470,800	5,345,360	11,816,160	54.8	22,649,680	13,015,270	35,664,950	63.5
1891–92	7,525,620	4,985,900	12,511,520	60.1	26,795,700	12,926,820	39,722,520	67.5
1892–93	4,779,720	4,921,240	9,700,960	49.3	26,769,520	12,340,100	39,109,620	68.4
1893–94	4,233,160	5,015,860	9,249,020	45.8	25,986,120	12,455,860	38,441,980	67.6
1894–95	5,080,060	5,506,180	10,586,240	48.0	24,013,920	14,182,160	38,196,080	62.9
1895–96	6,200,860	5,942,760	12,143,620	51.1	23,721,220	16,074,040	39,795,260	59.6
1896–97	6,841,320	6,988,880	13,830,200	49.5	25,743,000	17,269,480	43,012,480	59.9
1897–98	5,300,760	7,959,540	13,260,300	40.0	23,599,660	19,629,000	43,228,660	54.6
1898–99	5,267,760	8,576,060	13,843,820	38.1	23,704,740	19,397,420	43,102,160	55.0
1899–1900	6,298,340	8,523,120	14,821,460	42.5	26,062,660	20,266,320	46,328,980	56.3
1900–1	5,577,400	8,490,940	14,068,340	39.6	25,200,980	20,935,840	46,136,820	54.6
1901–2	4,808,620	8,444,100	13,252,720	36.3	25,174,840	20,488,100	45,662,940	55.1
1902–3	5,011,100	7,005,140	12,016,240	41.7	24,448,080	18,745,360	43,193,440	56.6
1903–4	5,943,600	7,365,380	13,308,980	44.7	24,904,420	20,594,520	45,498,940	54.7
1904–5	6,501,160	7,516,060	14,017,220	46.4	25,833,200	20,789,000	46,622,200	55.4
1905–6	5,166,960	7,494,080	12,661,040	40.8	24,870,720	21,842,900	46,713,620	53.2
1906–7	4,847,860	7,193,440	12,041,300	40.3	24,835,260	21,364,720	46,199,980	53.7
1907–8	5,791,100	7,660,280	13,451,380	43.1	25,313,020	21,537,360	46,850,380	54.0

Including "meat unenumerated" and less exports of dead meat (British and foreign).

The home production now forms 60 per cent. of the total supply, the average of the first quinquennium having been 69 per cent. The maximum home percentage was 73.8 per cent. in 1893–94; the minimum 58.4 per cent., in 1905–6, when foreign imports were at their highest, and the recovery to 60.8 in 1908 is due to the (probably temporary) shortage from North America.

Mutton in the same period increased from probably 8,000,000 cwts. to over 10,000,000 cwts. Here the maximum (10,445,000 cwts., which is problematical) occurred in 1899–1900, and the quantity has been, upon the whole, fairly stationary since. This is owing chiefly to the reduction in the home flocks of sheep up to 1905, while imports, although ever-increasing, have done so at a slackening rate in the past ten years (with a spurt in 1907–8). In spite of the increase since, the home production in 1907–8 was but 55.9 per cent. of the total, the lowest on record; it was probably 76 per cent. at the beginning.

The Tables and Diagrams show an analysis which indicates that the future sources of our over-sea meat-supplies are problematical.

The rough indications which may be deduced from such knowledge as we have of the live-stock now existing in different parts of the world, and from the trade statistics of the past thirty years, are that the surplus available from North America has now about reached its maximum, and will before very many years have passed tend downwards, its place being taken by the Southern Hemisphere.

The Southern Hemisphere, again, may be divided into two parts—South America, which is forging ahead fast, and Australasia, which possibly, so far as regards the average number of stock, is nearly stationary. North America seems to have about reached the maximum, and while a large maize harvest may cause an increase temporarily, the general tendency will be, with various ups and downs, towards a decline.

The rapid increase in population must, at some not very remote period, require more and more of the surplus for its own needs. Canada should, of course, greatly develop her herds upon her vast north-western prairies, and we should for some time draw increasing quantities thence, and less from the United States. Later on, the States will themselves make demands upon Canada, and our Colonies' meat will probably go to whichever (Britain or the States) pays best.

Turning to the untapped sources of supply, comprising the, as yet, undeveloped areas of Canada, Argentina, Russian Asia, South Africa, &c., as well as completely new territories such as the highlands of equatorial Africa (the latter probably unavailable until the deadliness of various diseases has been mitigated), there is no doubt ample space to rear stock for many years to come. Russian Asia in particular has room for an enormous development of its live-stock, but the produce may be absorbed by the needs of its own prolific population, or its surplus may be intercepted by Germany, whose growing dependence on imported food is an important factor in the problem of the meat-supply of the United Kingdom.

Taking the world over, sheep are pastured; and when grazing-lands are transformed into arable, mutton disappears, and is disappearing fast everywhere (except in Australia). Cattle are naturally pastured as far as possible; but when cattle-grazing lands are transformed into arable the cattle are still raised on the arable land, though of course not so cheaply. With absolutely virgin land, rich in fertilising constituents, like the Argentine plains, wheat will be raised year after year without manure; but later on, with the exhaustion of the soil, manuring and rotations become necessary. At this latter stage cattle come in again, and thus we get corn and cattle developing together as in the United States. They are developing side by side in Argentina, where the areas are so vast that the two need not at present be interdependent, as lucerne can be grown for cattle-feeding on the same land for years in the same way as wheat.

As mutton gets driven out by corn, so beef becomes a factor in the economic change, and as the needs of the population of the United States increase the South American stock-raisers will increase their produce. The tendency, therefore, seems to be that for our future supplies we must reckon on Argentina and South America generally for beef and Australasia for mutton. As South America develops their land and allows corn to supplant sheep to the increased benefit of beef, so Australia must develop in the way of increasing the product from their existing flocks by breeding sheep which will more nearly come up to the standard of weight common in the United Kingdom. The meat-supplies are thus bound to be secured for many decades to come.

IMPORTED MEAT TRADE

Some idea of the volume of trade in imported meat may be obtained from the following Table comparing the state of matters twenty-one years ago with the present time. The figures are given in comparative columns for 1888 and 1908, and the Table also gives the comparative prices ruling in London at the two periods.*

		1888.	1908.
Number of ships engaged in the frozen-meat trade . . .	No.	57	190
Carrying capacity (in 56-lb. carcases)	C/cs.	955,000	12,756,400
Total imports of mutton and lamb	C/cs.	1,975,448	9,651,418
,, ,, beef . . .	Qrs.	30,000	1,788,159

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* The above figures are taken from the "Review of the Frozen Meat Trade" by the courtesy of the publishers, Messrs. W. Weddell and Co., 16 St. Helen's Place, London, E.C., and we are also indebted to the same firm for a considerable number of other statistics which appear in this chapter. We have also to acknowledge our indebtedness to the Agents-General for the Colonies and others who have kindly put material at our disposal, giving facts relating to the meat industry. AUTHORS.

		1888.	1908.
Number of stores in London	No.	8	27
Storage capacity (in 56-lb. carcases)	C/cs.	300,000	2,730,500
Price of English beef at Islington Market (per Agricultural Returns)	Per lb.	3½*d.* to 7⅜*d.*	4⅛*d.* to 7*d.**
Price of English mutton at Islington Market (per Agricultural Returns)	Per lb.	4¾*d.* to 8¾*d.*	6½*d.* to 9¼*d.**
Prices at Smithfield :			
Scotch mutton	Avge.	7¾*d.* per lb.	7⅜*d.* per lb.
American beef (hinds)	,,	5⅞*d.* ,,	6¼*d.* ,,
New Zealand lambs	,,	6¾*d.* ,,	5¾*d.* ,,
,, (Canterbury) mutton	,,	4½*d.* ,,	4¼*d.* ,,
,, beef (hinds)	,,	4⅝*d.* ,,	3¾*d.* ,,
Australian mutton	,,	4*d.* ,,	3¼*d.* ,,
Argentine ,,	,,	3¾*d.* ,,	3½*d.* ,,
Proportion of frozen meat imports to total consumption in United Kingdom		2½%	20%
Proportion of imported beef. mutton and lamb of all kinds to total consumption in United Kingdom		12½%	35%
Cattle in Australia	No.	7,860,971	9,785,703*
,, New Zealand	,,	853,358	1,816,299*
,, Argentine Republic	,,	21,961,657	29,116,625*
Sheep in Australia	,,	79,111,615	87,676,031*
,, New Zealand	,,	16,564,595	20,983,772*
,, Argentine Republic	,,	66,706,097	67,211,754*

It is interesting to note that in the period covered by the foregoing statistics the population of the United Kingdom has increased from 37,000,000 to 44,000,000 persons, while the cattle has increased from 10,268,600 to 11,738,163, and the sheep from 28,938,716 to 31,255,917. It will be seen that the population has increased at a greater rate than the live-stock, and it becomes at once evident that outside supplies must be made available. The imports from abroad have increased more rapidly than the 1888 figures seemed to warrant, yet the values of the prime qualities of live-stock in the United Kingdom have been maintained. It must be borne in mind that the supplies of cheap imported meat have increased the consumption, so that at the present time the average of beef, mutton and lamb per head of the population is 89 lb. per annum, against 74 lb. at the earlier date.

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* Latest official figures available.

Of the 190 ships engaged in the frozen-meat trade, their distribution is as follows :

Route.	Ships.	Carrying Capacity.
Australia to United Kingdom, &c. .	48	1,913,000 C/cs.
New Zealand to London, &c. . .	45	4,033,700 ,,
Australasia, &c., or South America to United Kingdom, &c. . . .	29	2,794,400 ,,
South America to United Kingdom, &c. .	54	3,433,700 ,,
	176	12,174,800 ,,
Supplementary list . . .	14	581,600 ,,
Total	190	12,756,400 ,,

The supplementary list consists of six ships with a capacity of 180,000 carcases not at present employed in the carrying of meat, and eight more with a capacity of 401,600 carcases are being built. The bulk of the refrigerated space on these vessels is suitable for the carriage of either frozen or chilled meat.

The bulk of the shipments are to London and Liverpool, and in and around the metropolis alone there were on December 31, 1908, twenty-seven refrigerating stores, with a combined capacity of 2,730,500 carcases of mutton, available for the storage of imported meat. These were distributed as noted below :

		Capacity.
London & India Docks Co.	Victoria Dock . .	315,000 C/cs.
	Victoria Dock Extension	180,000 ,,
	West India Dock . .	90,000 ,,
	West Smithfield . .	90,000 ,,
	South Dock . . .	13,000 ,,
Union Cold Storage Co., Ltd.	Cannon Street .	220,000 ,,
	Blackfriars . .	80,000 ,,
	Red Bull Wharf .	135,000 ,,
London Central Markets Cold Storage Co., Ltd.	Poplar . . .	150,000 ,,
	Market Section . .	125,000 ,,
	Charterhouse St. Section	78,000 ,,
Anglo-American Cold Storage Co.		150,000 ,,
C. C. & D. Co., Ltd., Lambeth Wharf . . .		200,000 ,,
Hay's and Cotton's Wharf		220,000 ,,
Thames Cold Storage Co., Ltd.		160,000 ,,
New Hibernia Wharf		135,000 ,,
Blackfriars Cold Storage Co., Ltd., Purfleet Wharf .		90,000 ,,
Crown Wharf Cold Storage Co.		60,000 ,,
River Plate Fresh Meat Co., Ltd.		60,000 ,,
Sansinena's Frozen Meat Co., Ltd. . . .		55,000 ,,
J. Nelson and Sons. Ltd.		30,000 ,,

	Capacity.	
John Palmer's Store, Smithfield	30,000	C/cs.
Johnson, Cole, Brier and Cordery, Ltd. . . .	18,000	,,
Brook's Wharf	15,000	,,
Paul's Pier Wharf	14,000	,,
Eastmans, Ltd.	13,000	,,
B. W. Parsons	4,500	,,
Total capacity in 56-lb. sheep. . . .	2,730,500	,,

At the same date the freezing-establishments in the Colonies were:

	Works.	Daily Freezing Capacity.			Equivalent in Tons.	Storage Capacity, Tons.
		Lamb.	Sheep.	Cattle.		
Australia . .	29	20,250	37,900	1,780	1,850	40,265
New Zealand .	25	—	70,500	170	1,805	44,710
South America .	11	—	39,800	3,650	2,205	26,375
Total . .	65	20,250	148,200	5,600	5,860	111,350

It may be noted here that the term "frozen meat" is applied to meat carried at a temperature varying from 10° F. to 15° F. which arrives in the United Kingdom in a hard frozen state and requires to be thawed before it can be used (mutton and lamb are carried in a frozen condition). "Chilled meat" is applied to meat carried at a temperature of 28° F. to 30° F. which arrives in the United Kingdom in a comparatively soft condition, ready for immediate consumption, and mainly applies to beef from American ports.

In 1908 the high prices ranging for cattle in the United States made it impossible to send beef to the United Kingdom at a profit, and this enabled the Argentine shippers to make a record by sending 1,267,400 cwts. of chilled beef to British ports. In the same year the shipments from Canada were also reduced and compared as follows:

CHILLED BEEF

	United States.	Canada.	River Plate.
	Cwt.	Cwt.	Cwt.
1908 . .	1,432,142	18,040	1,267,400
1907 . .	2,417,604	39,585	705,000

The Bureau of Statistics of the United States Department of Agriculture gave the number of cattle and sheep in the States in 1908 as:

Cattle	71,267,000 head.
Sheep	54,631,000 ,,

The needs of the growing population of the United States make it quite certain that the supplies from their source will be a constantly diminishing quantity.

In South America the live-stock statistics give:

Cattle	72,334,600 head.*
Sheep	100,460,000 ,,

The latest returns indicate that there is every likelihood of Argentina being the principal source of supply in the British market. Uruguay and Patagonia have entered into the beef-, mutton- and lamb-shipping business, and it is possible that before long the increased demand may compel these countries to devote more attention to the question of quality.

Tables I., II. and III. (*see* pages 452 to 456) show the imports of mutton and lamb for twenty-nine years, from the year 1880, when the trade commenced. A comparative statement of the numbers of cattle and sheep in the United Kingdom and importations of live-stock, beef, mutton and lamb from all sources for six years; and a summary of supplies of beef, mutton and lamb showing the total estimated weight available for consumption in the United Kingdom for six years; and those taken together show not only the rise and development of the meat import trade, but also the important position these imports hold in the meat-supply of the British Isles.

THE MEAT-PACKING INDUSTRY

The meat-packing industry has been developed in many countries with a view to supplying the United Kingdom, and as has been shown, meat products are being imported into the United Kingdom in ever-increasing quantities.

The packing industry is carried on in the United States, Argentina and Australasia in practically the same manner, so that the description of one packing-house applies pretty much to the description of another. It is, therefore, of interest to take one particular packing-house, of which illustrations have been placed at our disposal and which illustrate the various departments in sequence; in this way we get a complete and comprehensive view of the whole of the operations which are carried on. The packing-house to which we refer is that of the Christchurch Meat Company of New Zealand and the description following is an excellent commentary on the illustrations. (*See* pages 463 to 472.)

Islington Works. The Christchurch Meat Company's main works are situated at Islington, which small township is on the main southern railway line, and being only seven miles from Christchurch, is within easy distance for visitors from this city to visit the most up-to-date and one of the largest meat-freezing works in the whole of Australasia.

Approaching the works we are astonished as we look upon the mass of brick buildings, covering acres of ground, with their tall chimneys, from which smoke is wreathing forth, indicating that within these buildings heavy machinery is in motion.

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* Including 30,000,000 estimated to be in Brazil.

We are taken out to the sheep-yards, which are at the back of the works, where we see large flocks of sheep and lambs standing awaiting their turn to pass through the factory. The yards are so arranged as to enable the shepherds to draft the numerous mobs correctly and expeditiously, and it becomes plain to us how much care is exercised at all times to keep the various lots distinct through all the various departments.

Nearing the slaughterhouse pens, the pet sheep are waiting. These, about four in number, are trained and used as decoys in leading the other sheep up the pen enclosures. The pets, however, do not wait to see how their friends fare, but go right on, and return through the middle of the slaughterhouse to lead the next lot to their doom.

The Slaughterhouse is well lighted and lofty, with louvred sides, which allow plenty of ventilation. There is accommodation for seventy-nine butchers, besides the assistants, who deal with the skins, offal, &c., and others engaged in their various works, making a fine industrial picture. On the concrete floor we notice there are several tramway lines, upon which run the trucks, some carrying the skins to the felling department, some taking the fat to the fat house and oleo department, others conveying the offal to the end of the slaughterhouse on to an electric platform, by which it is hoisted up to the elevated overhead tramway line, and run straightway into the tallow and manure buildings. Everything being promptly removed, the floor is kept perfectly clear of anything that might obstruct the butchers in their work. After the carcases are dressed they are suspended on the overhead trolleys, and are pushed along to one end of the slaughterhouse, where they are inspected by the duly qualified Government Inspector, and each carcase is branded with the official stamp. The kidneys are extracted and placed on the kidney packing-table, ready to be encased in stout parchment paper, counted, and packed neatly in the kidney crates for export. The carcases are then moved past the weight-box, and as they travel they are automatically weighed, the weights entered by a clerk and the proper grade label affixed, showing the grade and weight of each carcase.

The cooling-room, in which the meat is allowed to rest for some hours, is a large airy building provided with a great number of overhead parallel rails, on which about 6000 carcases can easily be hung at any one time to cool out the animal heat before allowing the meat to pass into the freezing-chambers, which are entered through heavy thick insulated double doors. After buttoning up our coats to try and keep out the cold, which feels intense, our eyes, in glancing round, catch sight of a thermometer, and we are at once anxious to know what the temperature may be ; we find it is about four degrees above zero, or not less than twenty-eight degrees of frost. After the various items of interest in the

TABLE I.: THE FOLLOWING TABLE DEALING WITH FROZEN MUTTON AND LAMB (IN CARCASES) IMPORTED INTO THE UNITED KINGDOM SINCE THE TRADE COMMENCED, SUMMARISES THE PRINCIPAL SOURCES OF SUPPLY AND THE LEADING PORTS OF DELIVERY

Year.	Australia.		New Zealand.		South America.			Other Countries.	Total Carcases.
	London.	Other Ports.	London.	Other Ports.	London.	Liverpool.	Other Ports.	U. K. Ports.	
1880	400	—	—	—	—	—	—	—	400
1881	17,275	—	—	—	—	—	—	—	17,275
1882	57,256	—	8,839	—	—	—	—	—	66,095
1883	63,733	—	120,893	—	17,165	—	—	—	201,791
1884	111,745	—	412,349	—	108,823	—	—	—	632,917
1885	95,051	—	492,269	—	190,571	—	—	—	777,891
1886	66,960	—	655,888	—	331,245	103,454	—	30,000 F	1,187,547
1887	88,811	—	766,417	—	242,903	398,963	—	45,552 F	1,542,646
1888	112,214	—	939,231	—	169,282	754,721	—	—	1,975,448
1889	86,547	—	1,068,286	—	167,936	842,000	—	—	2,164,769
1890	207,984	—	1,533,393	—	124,413	1,072,118	—	10,168 F	2,948,076
1891	334,684	—	1,894,105	—	160,340	950,797	—	18,897 F	3,358,823
1892	449,488	55,250 L	1,505,377	34,228 L	166,508	1,081,353	—	17,818 F	3,310,022
1893	636,917	—	1,821,595	36,003 L	109,808	1,263,915	—	16,425 F	3,884,663
1894	939,360	—	1,947,609	10,650 L	171,802	1,199,585	43,428	11,675 F	4,324,109
1895	969,943	35,560 LM	2,412,331	—	142,038	1,360,968	112,789	19,438 F	5,053,067

1896	1,565,360	77,883 M	2,211,895	—	245,573	1,392,700	154,007	—	5,647,418
1897	1,338,964	68,453 M	2,703,845	—	161,744	1,771,542	188,185	—	6,232,733
1898	1,238,653	10,000 M	2,784,101	—	201,895	1,935,365	260,077	—	6,430,091
1899	1,189,563	15,038 L	3,250,100	—	239,703	1,805,646	369,369	—	6,869,419
1900	906,766	37,158 L	3,157,060	—	271,432	1,773,381	288,024	—	6,433,821
1901	1,194,157	32,401 L	3,234,119	—	342,525	1,952,625	338,955	—	7,094,782
1902	648,929	75,368 LC	3,668,061	—	411,913	2,081,128	334,455	— U S	7,219,854
1903	449,090	28,947 L	4,566,257	17,503 C	650,004	2,141,469	326,964	— N A	8,180,234
1904	413,322	37,001 L	3,695,088	190,143 W	746,096	1,831,149	360,456	—	7,273,255
1905	1,190,584	177,854 LC	3,479,757	224,809 W	1,102,282	1,697,367	403,561	—	8,276,214
1906	1,339,677	392,651 L&c.	3,818,506	329,782 W	932,986	1,582,606	403,684	—	8,799,892
1907	1,762,047	575,884 L&c.	4,353,088	444,279 W	1,002,403	1,607,520	405,306	—	10,150,527
1908	1,214,753	616,493 L&c.	3,833,012	401,146 W	1,435,137	1,681,620	469,257	—	9,651,418
Totals.	18,690,233	2,235,941	60,333,471	1,688,543	9,846,527	32,281,992	4,458,517	169,973	129,705,197

L—Liverpool. M—Manchester. C—Cardiff.
L M—19,560 Liverpool and 16,000 Manchester. L C—68,558 Liverpool and 6810 Cardiff.
F—Falkland Islands. U S—United States additional 49,924 (chilled).
N A—North America additional 53,577 (chilled).
W—West Coast Ports (Liverpool, Cardiff, Bristol, Glasgow, Manchester).

TABLE II. :TABLE SHOWING NUMBERS OF CATTLE AND SHEEP IN THE UNITED KINGDOM, AND IMPORTATIONS OF LIVE-STOCK, BEEF, MUTTON AND LAMB FROM ALL SOURCES, IN EACH OF THE SIX YEARS FROM 1903 TO 1908 INCLUSIVE

				1908.	1907.	1906.	1905.	1904.	1903.
HOME SUPPLY	CATTLE	Cows and heifers .	No.	4,368,237	4,338,086	4,252,286	4,211,916	4,193,721	4,100,480
		Other cattle .		7,369,926	7,290,397	7,439,669	7,462,103	7,381,830	7,308,024
		Total . .	No.	11,738,163	11,628,483	11,691,955	11,674,019	11,575,551	11,408,504
	SHEEP	Breeding ewes .	No.	12,162,197	11,833,083	11,573,516	11,471,873	11,436,017	11,485,423
		Other sheep .	,,	19,093,720	18,178,136	17,636,519	17,604,904	17,669,092	18,173,440
		Total . .	No.	31,255,917	30,011,219	29,210,035	29,076,777	29,105,109	29,658,863
It is estimated that 25 per cent. of the cattle and 40 per cent. of the sheep are slaughtered each year.									
FOREIGN LIVE STOCK	CATTLE	United States .	No.	260,711	344,461	398,887	414,906	401,249	301,757
		Canada . .	,,	121,076	125,753	160,689	148,718	146,599	190,815
		Other countries	,,	1,343	1,801	1,639	1,515	1,684	29,974
		Total . .	No.	383,130	472,015	561,215	565,139	549,532	522,546
	SHEEP AND LAMBS	United States .	No.	64,218	88,584	84,184	150,095	294,804	171,386
		Canada . .	,,	12,167	14,485	14,296	28,240	77,835	83,291
		Other countries	,,	2,515	2,532	4,879	4,749	9,601	99,564
		Total . .	No.	78,900	105,601	103,359	183,084	382,240	354,241
FRESH KILLED	BEEF	. Continent, &c.	Cwt.	15,107	3,520	3,929	15,400	18,523	70,638
	MUTTON	Continent, &c.	Cwt.	288,612	231,572	264,971	257,478	278,326	272,074

CHILLED	BEEF	United States .	Cwt.	1,432,142	2,417,604	2,426,644	2,232,206	2,395,836	2,693,920
		Canada . .	,,	18,040	39,585	8,415	5,231	9,044	5,351
		River Plate (est.)	,,	1,267,400	705,000	750,000	653,560	347,000	229,000
		Total . .	Cwt.	2,717,582	3,162,189	3,185,059	2,890,997	2,751,880	2,928,271
	MUTTON	United States .	Cwt.	3,881	5,403	2,670	6,283	4,148	41,863
		Canada . .	,,	—	—	—	—	4	212
		Total . .	Cwt.	3,881	5,403	2,670	6,283	4,152	42,075
FROZEN	BEEF	Australia . .	Qr.	75,800	73,117	13,112	10,276	46,537	45,587
		New Zealand .	,,	179,002	220,162	121,858	89,463	104,467	91,994
		South America .	,,	1,533,357	1,321,110	1,314,703	1,168,133	789,109	565,642
		Total . .	Qr.	1,788,159	1,614,389	1,449,673	1,267,872	940,113	703,223
	MUTTON	Australia . .	C/cs.	625,067	940,377	558,432	461,902	121,799	213,880
		New Zealand .	,,	1,690,407	1,973,035	1,761,459	1,751,229	1,980,639	2,426,081
		South America .	,,	3,263,086	2,888,123	2,799,170	3,030,130	2,730,560	2,943,988
		Total . .	C/cs.	5,578,560	5,801,535	5,119,061	5,243,261	4,832,998	5,583,949
	LAMB	Australia . .	C/cs.	1,206,179	1,397,554	1,173,896	906,536	328,524	264,157
		New Zealand .	,,	2,543,751	2,824,332	2,386,829	1,953,337	1,904,592	2,157,679
		South America .	,,	322,928	127,106	120,106	173,080	207,141	174,449
		Total . .	C/cs.	4,072,858	4,348,992	3,680,831	3,032,953	2,440,257	2,596,285

TABLE III.: SUMMARY OF SUPPLIES OF BEEF, MUTTON AND LAMB SHOWING TOTAL ESTIMATED WEIGHT AVAILABLE FOR CONSUMPTION IN THE UNITED KINGDOM IN EACH OF THE SIX YEARS FROM 1903 TO 1908 INCLUSIVE

		1908.	1907.	1906.	1905.	1904.	1903.
		Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
HOME-GROWN	Beef	786,000	778,720	782,950	781,750	775,150	764,000
	Mutton and lamb	334,900	321,560	313,000	311,550	311,850	317,800
	Total	1,120,900	1,100,280	1,095,950	1,093,300	1,087,000	1,081,800
FOREIGN LIVE-STOCK	Beef	123,150	151,719	180,390	181,652	176,635	167,961
	Mutton and lamb	2,110	2,828	2,769	4,904	10,238	9,488
	Total	125,260	154,547	183,159	186,556	186,873	177,449
FRESH-KILLED, &c.	Beef	755	176	196	770	926	3,532
	Mutton and lamb	14,430	11,578	13,248	12,873	13,916	13,603
	Total	15,185	11,754	13,444	13,643	14,842	17,135
CHILLED	Beef	135,879	158,109	159,253	144,549	137,594	146,413
	Mutton	194	270	134	314	208	2,104
	Total	136,073	158,379	159,387	144,863	137,802	148,517
FROZEN	Beef	144,965	128,465	117,007	106,556	78,981	58,035
	Mutton and lamb	204,938	217,758	191,052	177,360	160,615	185,123
	Total	349,903	346,223	308,059	283,916	239,596	243,158
	Total of beef	1,190,749	1,217,189	1,239,796	1,215,277	1,169,286	1,139,941
	Total of mutton and lamb	556,572	553,994	520,203	507,001	496,827	528,118
	Grand total	1,747,321	1,771,183	1,759,999	1,722,278	1,666,113	1,668,059

freezing-chamber have been explained to us, we pass into the frozen store-rooms.

The temperature here is very much the same as that of the freezing-rooms, though the rooms themselves are lofty, about 14 ft. clear between floor and ceiling. We notice the various stacks of meat all encased in clean white stockinette branded bags ready for shipment. The different grades of meat, and the meat held on owners' account are kept in separate stacks, so that it is then easy to ship out any brand or lot of meat without removing any other carcases. On inquiring, we find that the storage capacity of these rooms is 120,000 carcases of sheep and lambs. There is also a storage capacity of 16,000 sheep and lambs in the frozen store cellars if required. The method of loading out into the specially insulated railway vans is very easily effected. The company's own locomotive shunts the vans alongside the freezing store-rooms under a covered way. Chutes are placed in position from the stack of meat required to be shipped to the inside of the railway van. These chutes are then moistened with clean water, which rapidly turns to ice, which makes a slippery surface on which the carcases are placed, and with a slight push run right into the vans outside. As the carcases pass from the rooms into the van, a clerk stands with a tally book and checks each carcase as it is loaded out.

The beef slaughterhouse and cooling-rooms have just been rebuilt and are substantial brick structures with walls plastered with cement, and louvred sides which give a perfectly pure air circulation. The hoisting-gear for the handling of the bullocks is most complete and up-to-date in every respect. We had a special construction point shown to us, in that the whole of the building has no sharp internal angles, all are hollowed in semicircular fashion. The drains of the building are all constructed in the same way, so that there are no crevices in which the refuse can accumulate. The same system, despatch and cleanliness which are evident all through the works, are evident here also, and subject to certain necessary modifications, the same methods of handling the meat and by-products are also adopted.

The Boiler-house and Engine-room. Our next visit was paid to the boiler-house and engine-room, where all the power is generated for this vast business. In the boiler-house we see huge Lancashire boilers, and boilers by Babcock and Wilcox, working at a pressure of 100 lb. per square inch. There are mechanical stokers fixed to the boilers, these being especially good for continuous even feed firing, and where such conditions obtain as to bring about a saving of labour. In the engine-room we find two Haslam refrigerating-machines. The system of freezing is the Ammonia process, the means of distribution being by means of direct expansion pipes and also by cold air circulation, the former in the freezing-rooms, and the latter in the store-rooms. It was explained to us what extreme care must be exercised when turning on the ammonia valves, so as to allow only the correct amount of ammonia to circulate through the pipes in the freezing-rooms. Next in importance to the freezing-machines are the electric light and power generators. They are steam-driven Beliss and Morcom self-lubricating high-speed engines coupled direct to large dynamos. The generated current is conveyed to the switchboard and distributed over the works providing both light and power as required. There is also an ice-making plant and store-room, which plant is kept busy during the summer months in supplying the local demand for ice for cool storage for meat at the company's butchers' shops in Christchurch and for hotel, fishmongers', medical and other purposes.

The felling-department next claims our attention. Here the skins are thrown into the washing-dollies, and are washed by means of a revolving paddle-wheel driven from an overhead shafting. After the skins have been sufficiently washed, they are taken from the dollies by a travelling elevator which is also worked from the same shafting. The skins are now thrown into hydro-extractors, which are electrically driven, revolving at a great speed. The centrifugal force, caused by the high rate of speed at which the hydro-extractors revolve, forces the water from the skins through the perforated sides, and dries them sufficiently for the next process, that of painting with a solution of thick green-looking paint, which we find is composed of sulphide of sodium and lime, used as a depilatory, applied to the flesh side of the skin with large brushes. The skins are then wheeled out into the adjoining room, and carefully stacked on the concrete floor, where they are allowed to remain for the necessary length of time, about twenty-four hours, and then put into trucks and run by an electric elevator on to the next floor to the pullers' benches. Here the wool is pulled from the pelt, and the wool classified into the various grades. The pelt is then trucked and run into the pelt department, which will be referred to later. The wool is gathered up and taken along to the wool dryers, to finally dry out any remaining moisture in the wool. These machines are electrically driven, and inside are many layers of revolving mattresses, the wool being conveyed from one mattress to the other. The drying is effected by hot air circulation, and when the wool has passed right through the machine, it is blown by a strong blast of cold air up a large pipe to the baling floor. The wool is now put in the separate bins, and when sufficient quantities are ready, is baled and pressed by hydraulic power.

The Pelt Department. Here we see another very large building with a great number of machines used for the pelt-curing process. First, the pelts as received from the felling department pass through a series of washing-dollies, to wash off the composition that was put on to remove the wool. After all traces of this paint have been washed off, the pelts are passed through fleshing-machines. These machines remove any fleshy substance that has adhered to the pelt. The machine itself, although heavy looking, is simple in its action, in some respects resembling a printing-machine. The pelts are placed on a feed-table, which is a semi-circular cylinder covered with a soft rubber cushion, which serves to protect the pelt while it is being worked. By means of a lever, this cylinder is set in motion, and the pelt is passed between the cylinder and a revolving fluted and spined roll which strips off the flesh. The pelts now pass through other chemical processes, and, when cured, are sorted into dozens of the various grades, and stacked in heaps, after which they are packed in casks ready for shipment.

The oleo house, where the somewhat intricate work of manufacturing oleo is carried on, is a large two-storey brick building. The fat, brought from the slaughterhouses, is tipped from the trucks into large concrete holders filled with pure cold artesian water, constantly running. This water washes out any trace of blood there may be in the fat. The fat is then forked into another holder, and washed again several times. After remaining in the running water, under constant supervision, for a sufficient length of time, the fat, now properly hard, is elevated and passed through a cutter, which reduces the rough fat to a suitable state for treatment in a steam-jacketed pan, from which it is passed into a second steam-jacketed pan, and after remaining there for the necessary length of time, it is run through pipes into holders in the seeding-room. This room has to be kept up to an even temperature. After some further treatment the oleo is ready to be casked.

Bacon Department. By no means the least interesting working of the company is that in connection with the ham and bacon-curing establishment.

To meet the ever-increasing demand for the company's hams and bacon, extensive alterations have recently been made to the portion of the works utilised for killing and curing.

This industry, although in its infancy in New Zealand, is peculiar in that it is self-contained. The raw material is grown in the Dominion, and is the means of a very steady source of income to the farmer, and the cured article is for the most part disposed of locally.

The pigs, after being selected by the company's expert on the farm, are received at the factory by rail, the trucks running right alongside the receiving pens, and a movable platform connecting the various pens with the trucks.

The pigs are then inspected by the foreman of the department, and should any show the least semblance of disease they are at once rejected alive.

They are then allowed to stand in the races to cool, after which they are taken into the slaughtering-pens, where about half a dozen pigs are held at a time.

A man stands in this inner pen and slips a chain shackle round one of the legs of the pig, and the pig is immediately carried by the revolving wheel and run on to an iron rail by the shackle, where it is "stuck" in such a manner as to cause the whole of the blood to quickly discharge. The pig is then travelled along the rail and drops into a large trough of hot water, where it is thoroughly washed and then quickly hoisted on to a circular table, round which operators stand, each man removing one part of the hair only, and then passing it on to his neighbour and so on. More quickly than we can describe, the pig arrives at the end of the table, where it is shackled by the feet on to a movable carriage attached to a revolving crane, which is swung round opposite a huge furnace, where a fierce scorching fire is kept burning, into which the pig is quickly passed on the overhead carriage.

A few minutes suffice, and the pig which went in beautifully white comes out scorched and black, and this deposit is at once removed by copious supplies of cold water and vigorous scraping. From this point, as it passes along, experts quickly perform the various duties—disembowelling, cleaning, trimming, removing head, lard, &c., and cutting down the pig—each man simply doing one portion of the work, the whole being done with wonderful despatch and great accuracy.

After being carefully examined by the Government Inspector for final inspection the pig is sent away to the hanging-room, where it is allowed to cool before being cured. Here it remains until it is what is termed "set." Then it is passed into the chilling-room, and after remaining there the necessary length of time, it is removed to the curing-chambers. It is here that the real difficulty in handling begins.

Bacon-curing is a familiar process to every housewife, and the methods which are adopted on a large scale are merely modifications of the smaller operations; and as such have been in use in America and the Old World for many years in all up-to-date factories, the main features of the department under view were the absolute cleanliness and careful supervision exercised in every detail.

After remaining in the curing cellars the necessary length of time for the curing material to take effect, the pork is taken out and is what is known as "green" bacon.

The bacon is then removed to quite a different temperature. After coming out of the cellar, it is washed in hot water, and after being hung in the drying-room, passes into the smoke-house, which is a large brick building something like a kiln, capable of holding a very considerable quantity of bacon at a time. After this, it is again hung in a drying-room, so as to ensure the bacon being in a thoroughly dry condition before being put on the market.

From the quantities we saw passing through the various stages, it is evident that the operations of the company in this particular branch are on a very large scale. We understand that the company's activity extends right throughout New Zealand, and it only remains for the farmer to supply the company with regularity throughout the year to firmly establish an export business.

We were then shown through the small-goods house and lard-refining department. Here the pure leaf lard is refined and put up into casks for export and bladders and one-pound pats for the local requirements. The small trimmings saved when cutting down the pigs are turned into succulent pork sausages, to say nothing of the many small delicacies appertaining to the small-goods business.

Preserving and Tin-making Department. The canning-department is one of the most interesting branches of the company's activity. The preserving work of the company exists as an absolute necessity for the utilisation of the various by-products of the slaughterings, and for the disposal of too fat or heavy-framed sheep, which in the ordinary way would not find a ready sale in the retail shops. The same rigid inspection, however, is applied to all the products handled in this department.

All meat is Government inspected before it is sent to be preserved and is again thoroughly inspected by the company's own foreman both before and after canning so as to ensure absolute purity. Every care is taken that human foresight, experience and skill can suggest.

The meat and tongues having been carefully examined are thoroughly cleaned and placed in large pickling vats. After remaining there for the necessary length of time, the meat is placed on benches where it is carefully filled into tins and passed through the various processes necessary to ensure its safe keeping.

We are assured that the entire cutting, cooking and different processes of canning done in this department, for brightness and cleanliness, cannot be surpassed by the most accomplished housewife. One noticeable feature is the fact that most of the products are handled by machinery.

The company's specialities in this department comprise the whole range of preserving meats, sheep tongues in tins and glass jars, beef and mutton in all their varieties, brawn, minced meat, miner's lunch, ox-cheek, ox-tongues and succulent pork sausages. The small-sized tins are put up for local requirements and the larger tins for the London market. These are all nicely labelled and put up in an attractive form.

The company has its own tin-making plant, and is thus able to turn out the most reliable cans, and these are thoroughly cleansed and sterilised before being used.

One product which is worthy of special mention is the extract of meat.

The meat used in the manufacture of extract is examined by a duly qualified Government Meat Inspector at the time of slaughter, and if the slightest sign of disease is present, the meat is condemned and is immediately sent to the digestors, where it is converted into by-products, and no part of it is permitted to be used for food in any form whatever.

Extract of meat is a product which goes to illustrate the progress of the meat industry during comparatively recent years, and the rapid evolution from the slaughterhouse to the well-equipped work of to-day where every department is conducted under the most advanced scientific methods.

The extract is taken from the meat by the most approved methods, all fat, albumen and gelatine being carefully and completely removed by filtration.

Manure Department. On going through the bacon and preserving departments, we thought we had seen every use to which the by-products could be put, but on being taken through the boiling-down and manure departments, we found that all waste, including blood, bones, pieces, and everything which had not been previously turned to account, is utilised for fertilisers and it is here that the old creed, "Waste not" is fully exemplified.

All the cunning of the chemist has been called into service to save, to make the most of every scrap of material in hand, and to discover new ways in which some element of waste may be diverted from uselessness to use.

Nitrogen being the chief element in plant-food, and this being abundant in the refuse matter originally thrown away as waste from the slaughter-house, a most important economic advance has been made in the step which turned this large volume of waste material into fertiliser. Carcases condemned by the inspector, also bones, and all meaty matter remaining in the bottom of the large vats, after rendering of the tallow, are dried by hot air and then used as a source of nitrogen, and forms the principal ingredient of the fertiliser which is mixed with potash, phosphates, &c.

The blood accumulated from the killings is also dried, and being exceptionally rich in nitrogen, that necessary element of plant-food, is also mixed with phosphates, &c., besides being used in the pure state as a food for calves and poultry.

The Casing-department. We now go along to view the casing-department, where we see the intestines of the slaughtered stock being treated. These are termed bungs and runners, and after being scraped, cleaned and washed in many different waters, are salted down and put into casks. When cured, these by-products are termed sausage casings, and are ready for use for different classes of goods according to size.

The factory has many subsidiary departments, all of which are fitted out in a complete manner. Such departments are: the chief engineer's offices, the chemical laboratory, the cooperage, and the box-making yard. The drainage and water-supply are perfect in their way, and advantage is taken of these in connection with the farm which surrounds the factory and which is administered from there. The offices, indeed, are not the least interesting part of the whole concern, and the administrative and clerical staff is as complete as so large and interesting a concern requires.

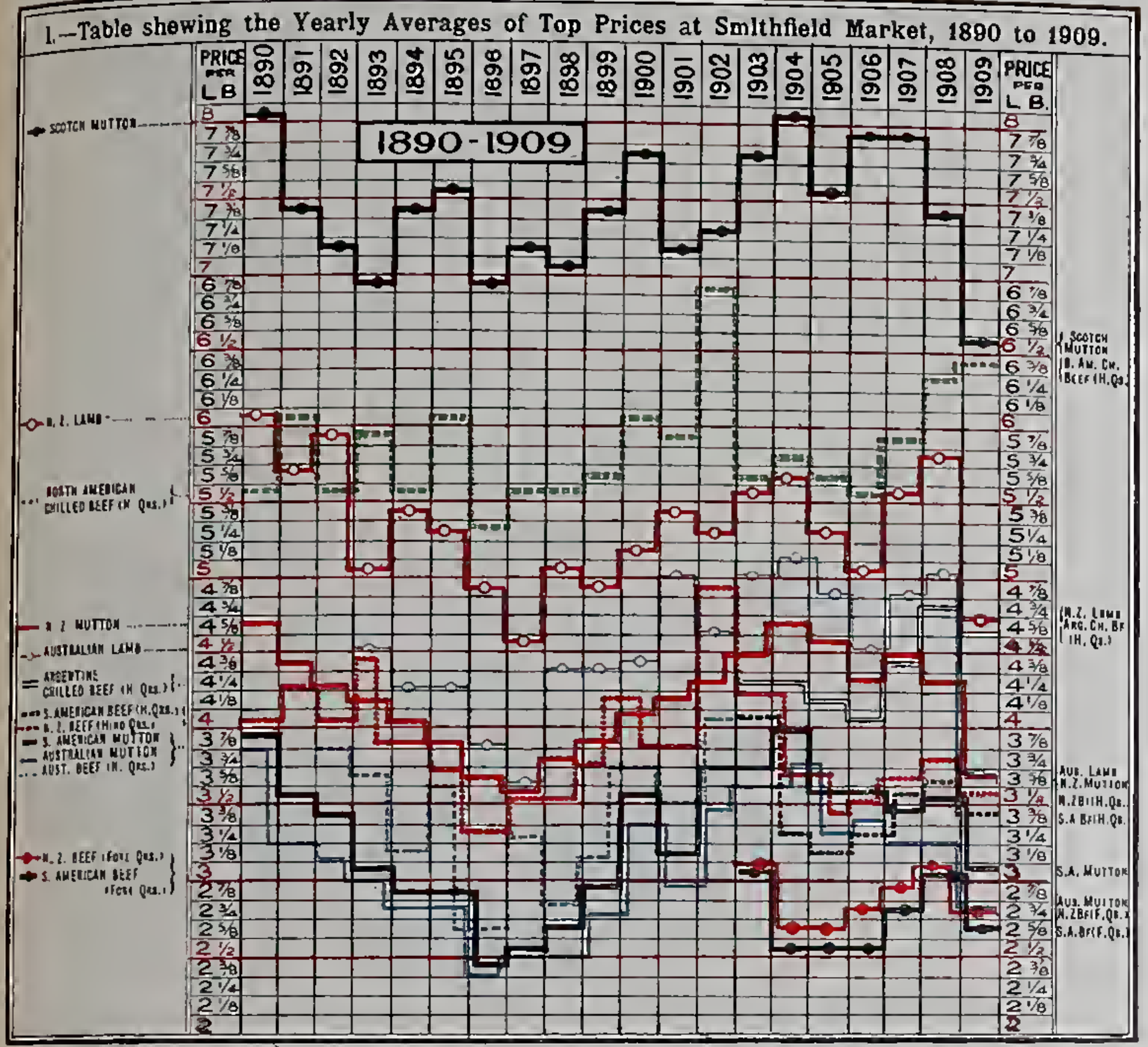


Table giving the yearly averages of prices for beef, mutton, and lamb at Smithfield Market, London, from the year 1890 to 1909 inclusive.

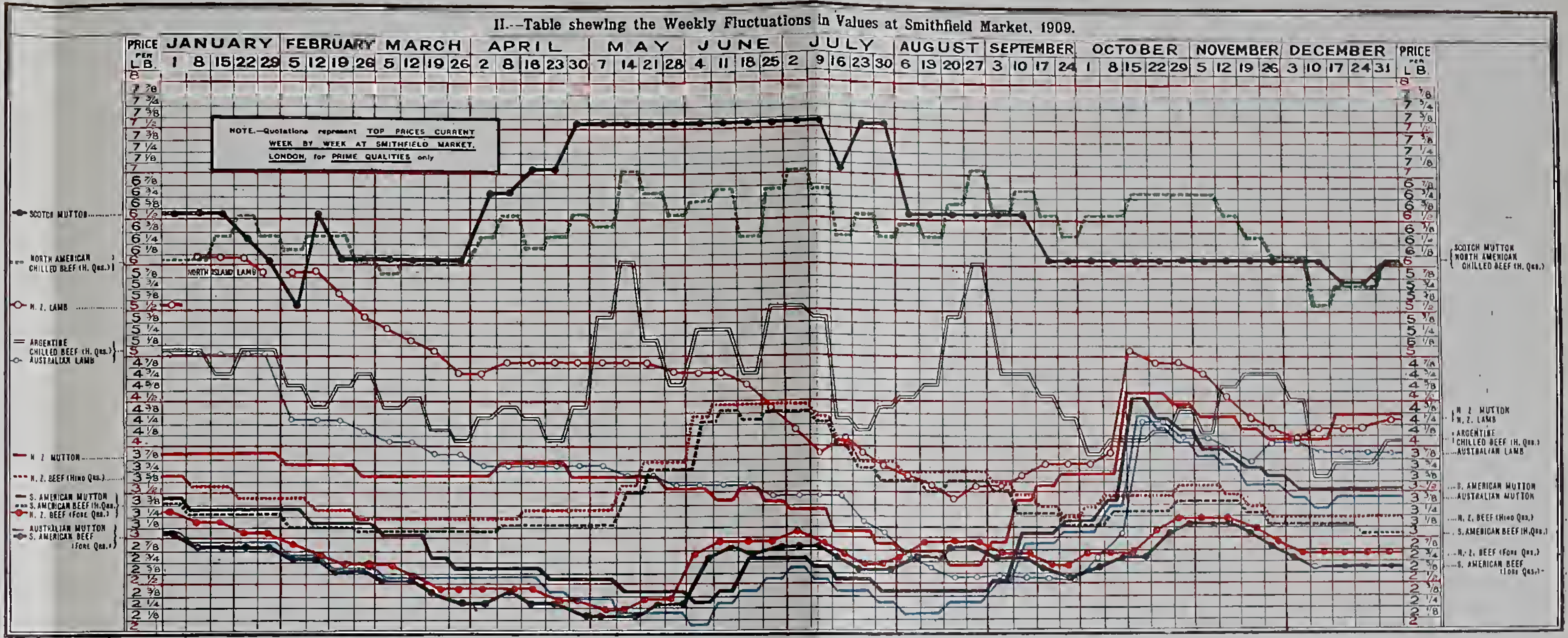
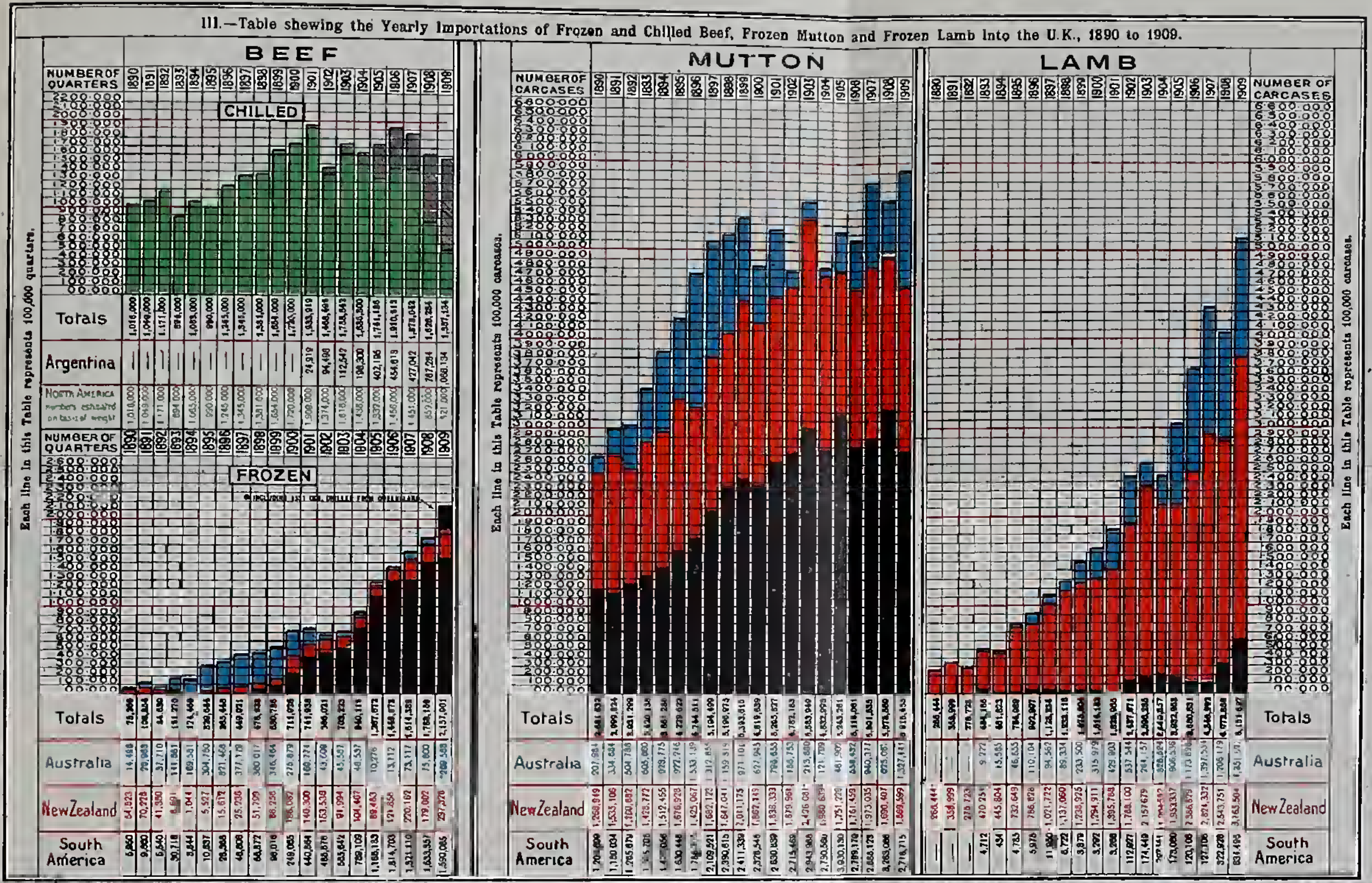
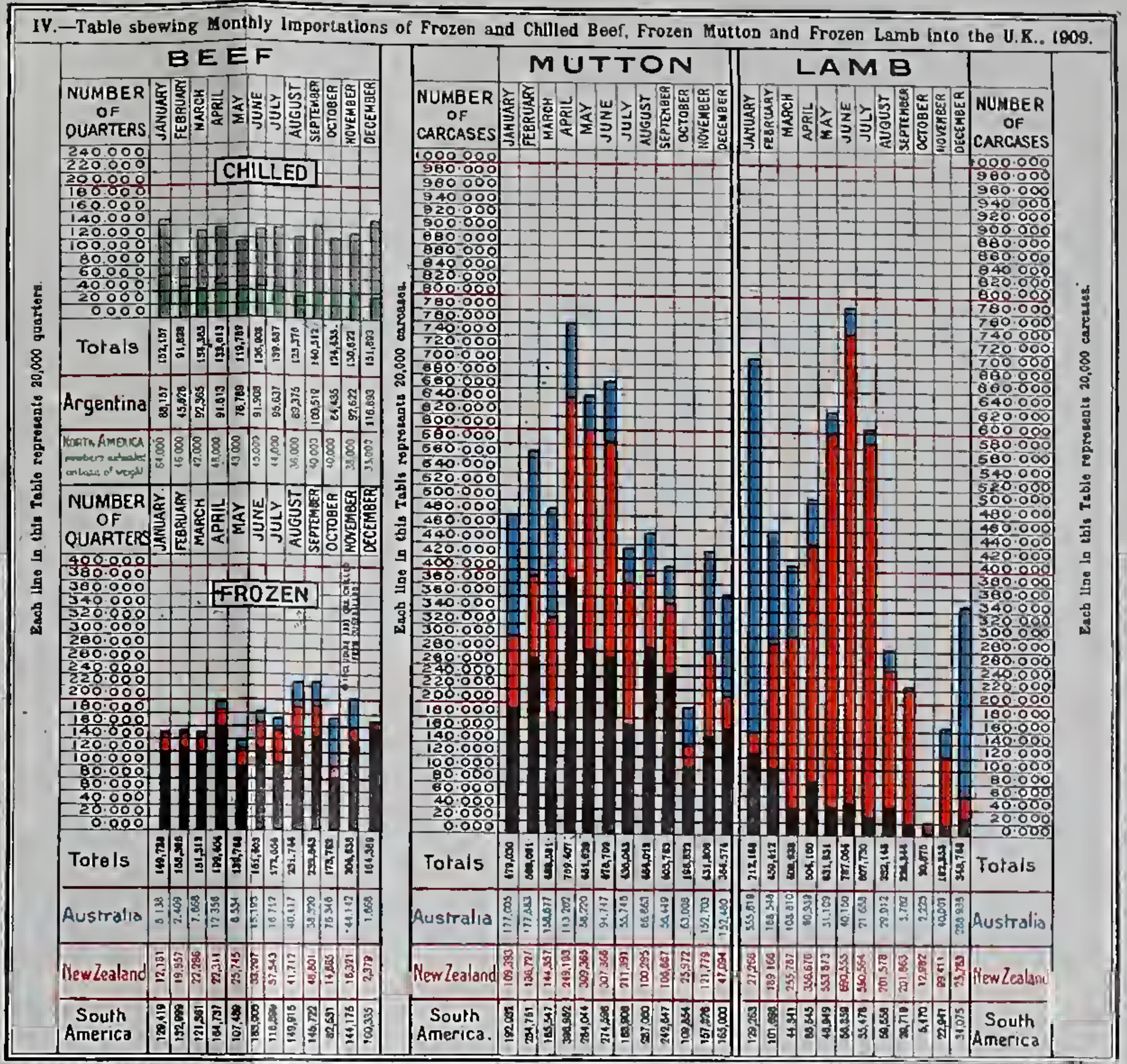


Table giving the weekly fluctuations in values of beef, mutton, and lamb at Smithfield Market, London, during the year 1909.

We are indebted to the courtesy of Messrs. W. Weddell and Sons, of St. Helen's Place, London, for the use of both tables.—AUTHORS.





ENTERED AT STATIONERS' HALL.

NOTE.—Throughout these Tables Australian prices and quantities are shown in BLUE, New Zealand in RED, South American in BLACK, and North American in GREEN.

Diagram showing the yearly importation of frozen and chilled beef, frozen mutton and frozen lamb into the United Kingdom in each year, from 1890 to 1909 inclusive.

Diagram showing the monthly importation of frozen and chilled beef, frozen mutton and frozen lamb into the United Kingdom during the year 1909.

We are indebted to the courtesy of Messrs. W. Weddell and Sons, of St. Helen's Place, London, for the use of both tables.—AUTHORS.

THE MEAT INDUSTRY IN NEW ZEALAND

SCENES IN THE WORKS OF THE CHRISTCHURCH MEAT COMPANY

The Company's works at Smithfield (Timaru), South Canterbury

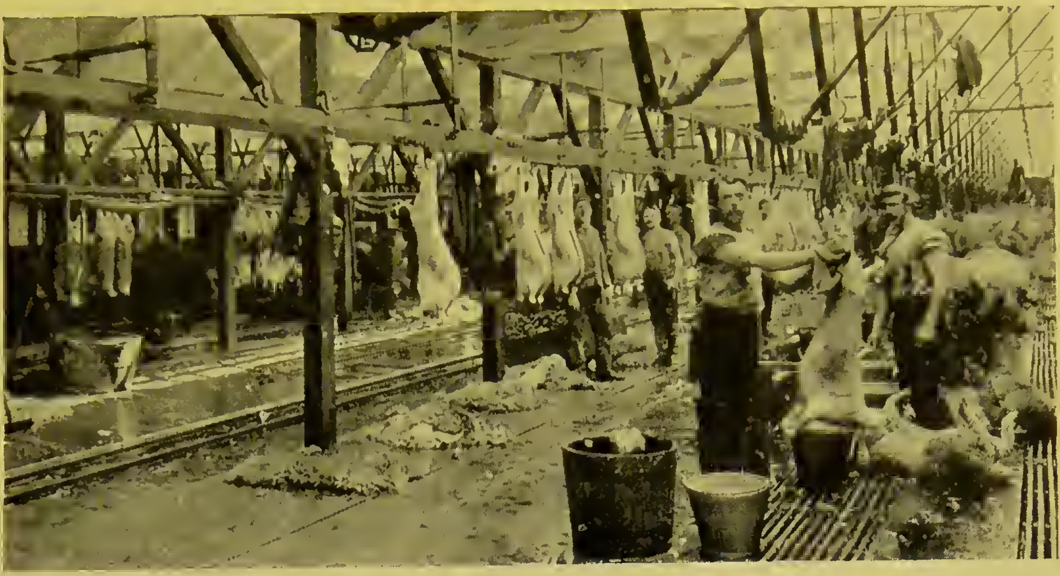
The works at Picton, Marlborough

Wool-drying on ground

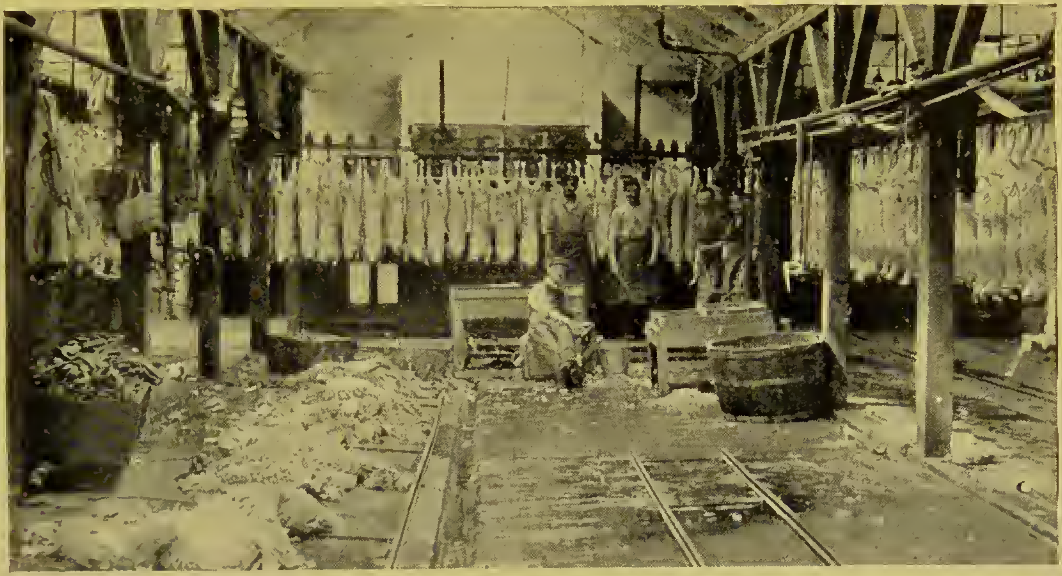
Stock in yards awaiting slaughter for export

Pigs in the Islington yards awaiting slaughter

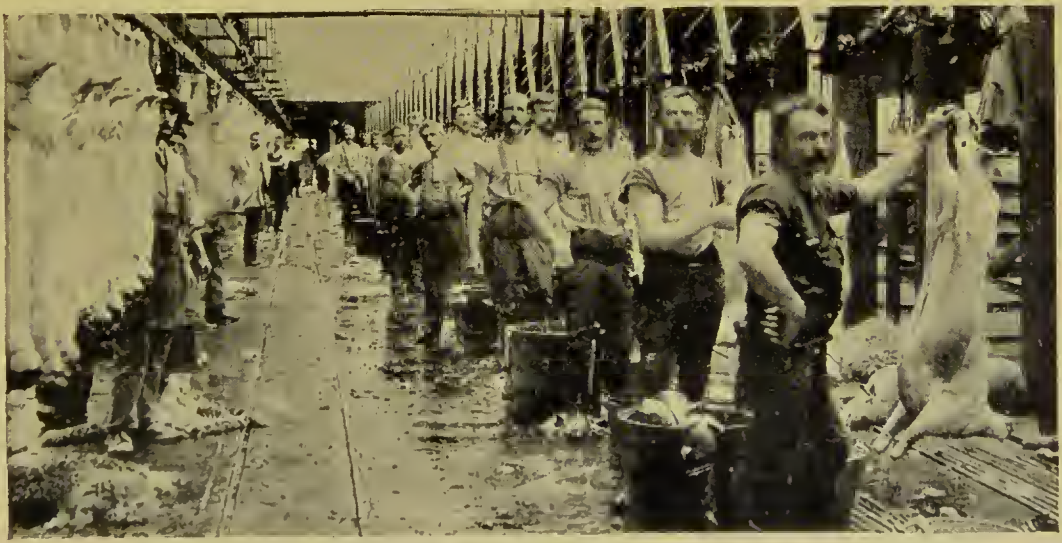
The Company's exhibits at the New Zealand International Exhibition, held at Christchurch in 1906–7



One of the slaughtering-floors at Islington

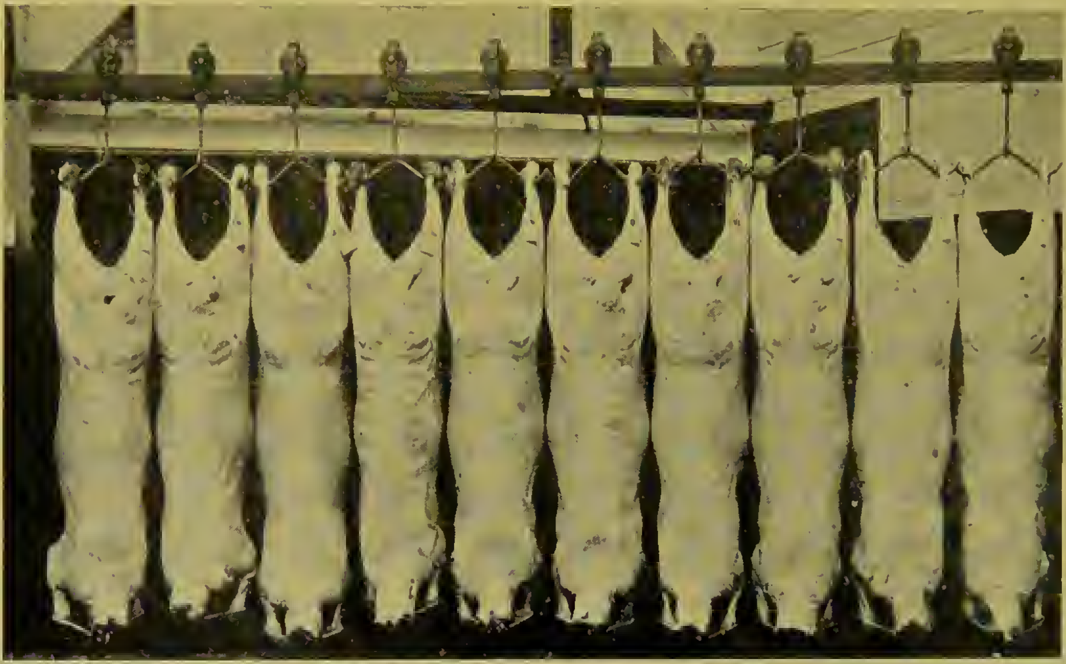


Carcases dressed ready to be weighed

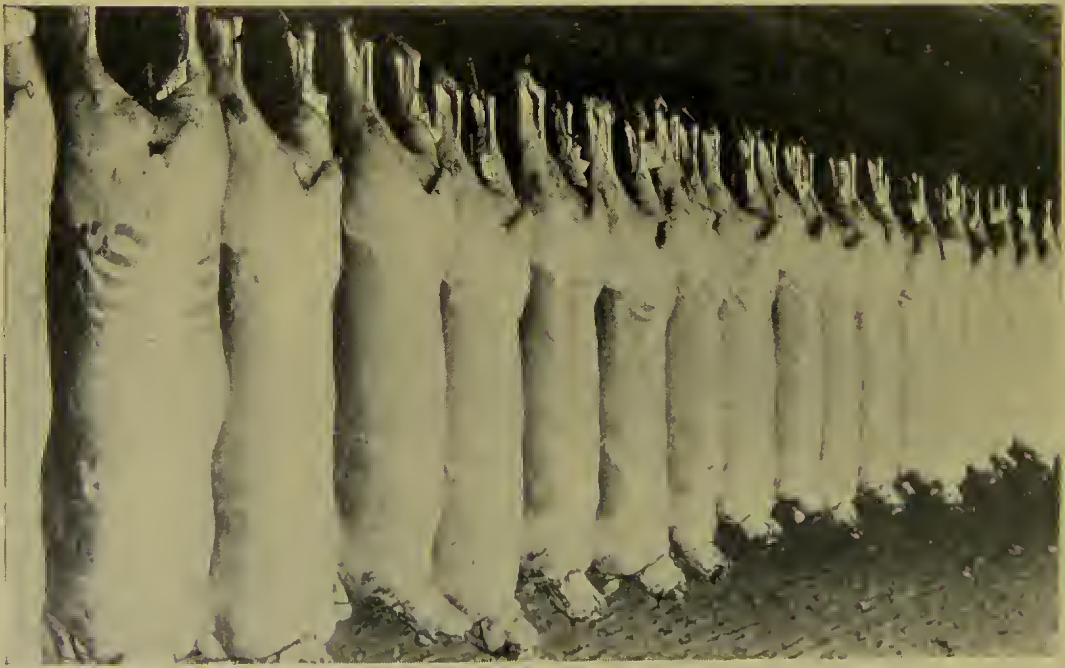


Slaughtering-floor at the Islington works

Pen of prize lambs awaiting slaughter

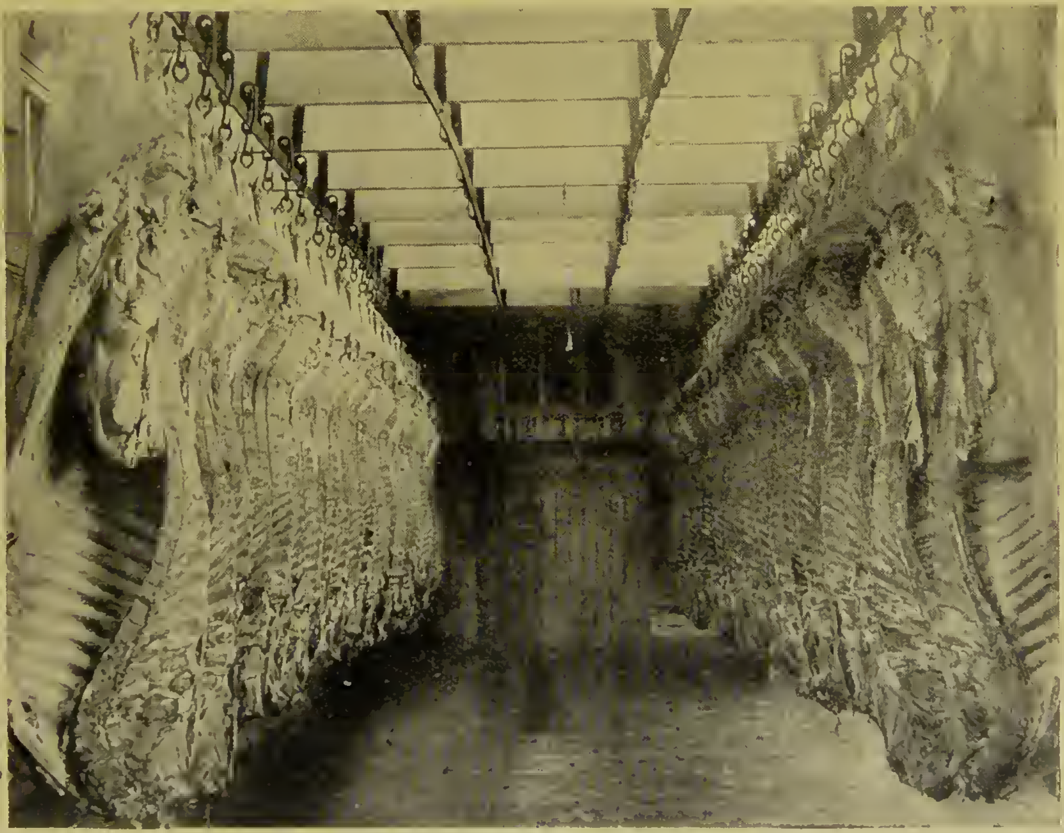


Carcases of the same lambs dressed for export



Prime quality of mutton in cooling-room, prior to being frozen

Bacon and hams in drying-room



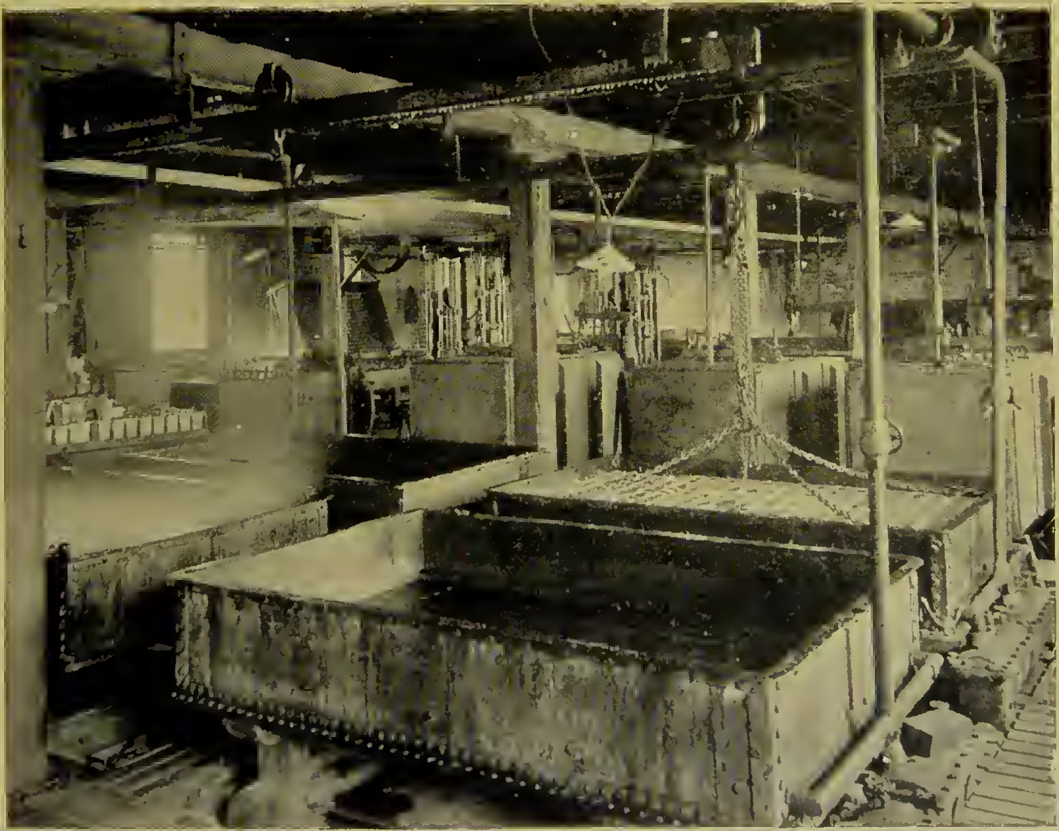
Beef for local consumption

In the fellmongery, showing dolly washers on right, hydro-extractor in centre, and painting on the left

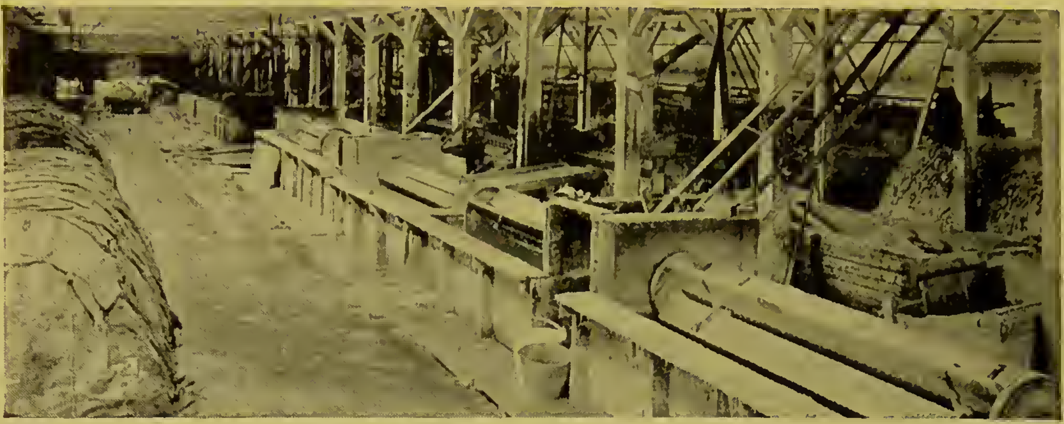
In the fellmongery, showing putting-floor and sorting-bins

In the fellmongery, showing baling-room and press

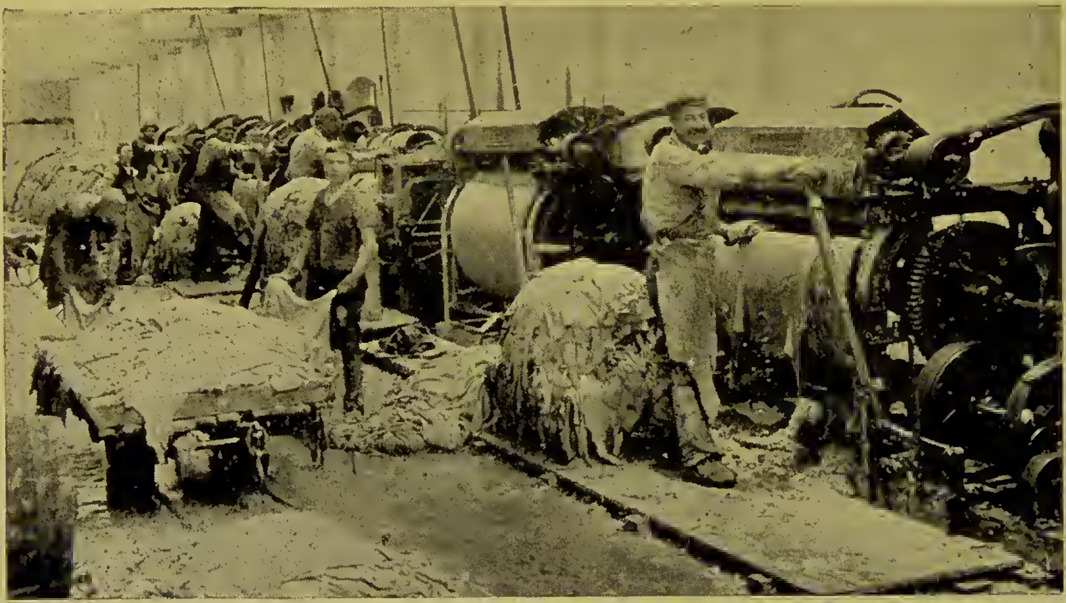
Bacon and hams in curing-cellar



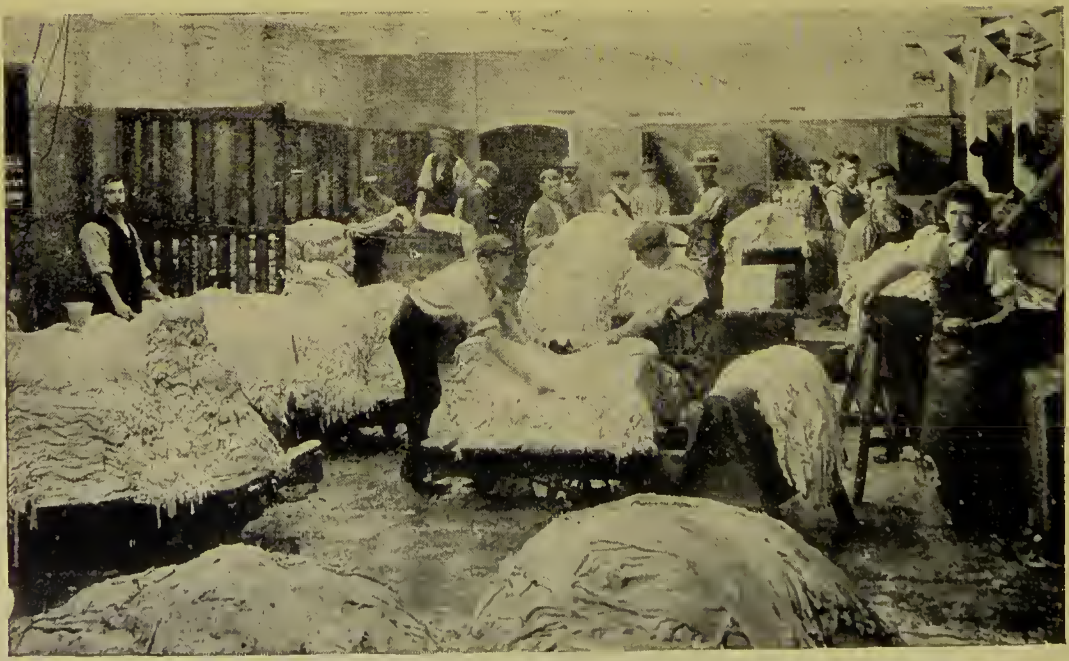
In the preserving department



Pelt-curing department, showing dollies, &c.



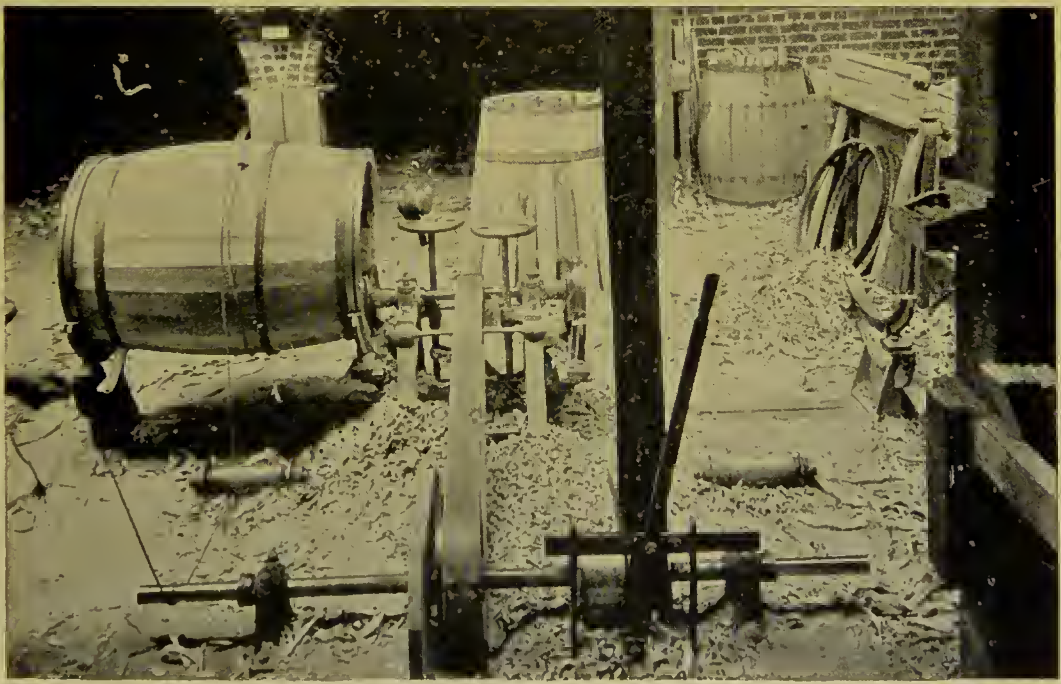
Pelt-curing department. Fleshing- and scutching-machines



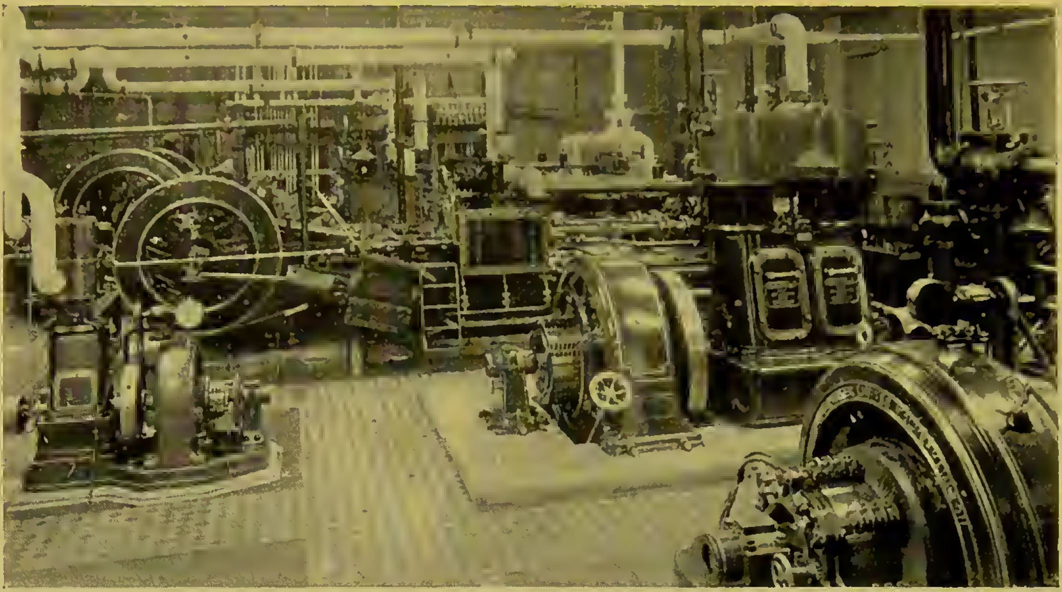
Pelt-curing department. Pelts being classed and packed for shipment

Workmen's library: erected by the company

Bag-room : where wraps for covering carcases are made

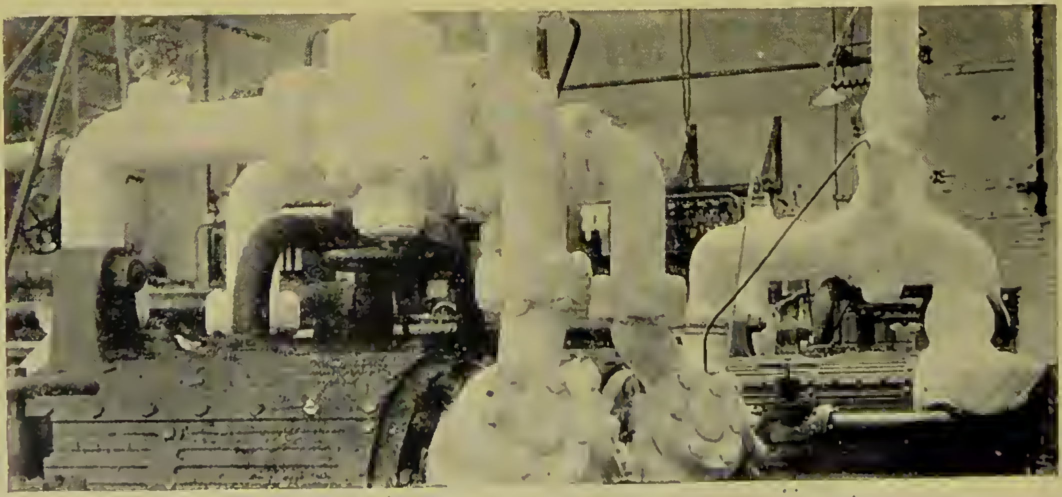


The cask-making and cooperage department



Engine-room, showing electric power generators in foreground, and ammonia compression refrigerating machines towards the rear

Railway siding within the works, showing a long train-load of tallow and other produce



Refrigerating machinery, showing frost and snow on pipes

CHAPTER V

THE MEAT-TRADE AS CARRIED ON IN SHOPS

NOT the least notable feature in connection with the meat industry is the large amount of employment which it gives. In the present year 1910, there are said to be some 43,000 meat purveyors' establishments in the United Kingdom, and it requires no very difficult calculation to see that the average of these will give employment to at least four persons. The families depending on these businesses may be put down at another four persons, which gives a total of eight, making the huge number of 344,000 persons who are, more or less, dependent upon meat-purveyors' shops.

Small Shops for Meat-purveyors. The shop is the simplest kind of meat-market and may be said to date back to an obscure period, which cannot be definitely fixed.

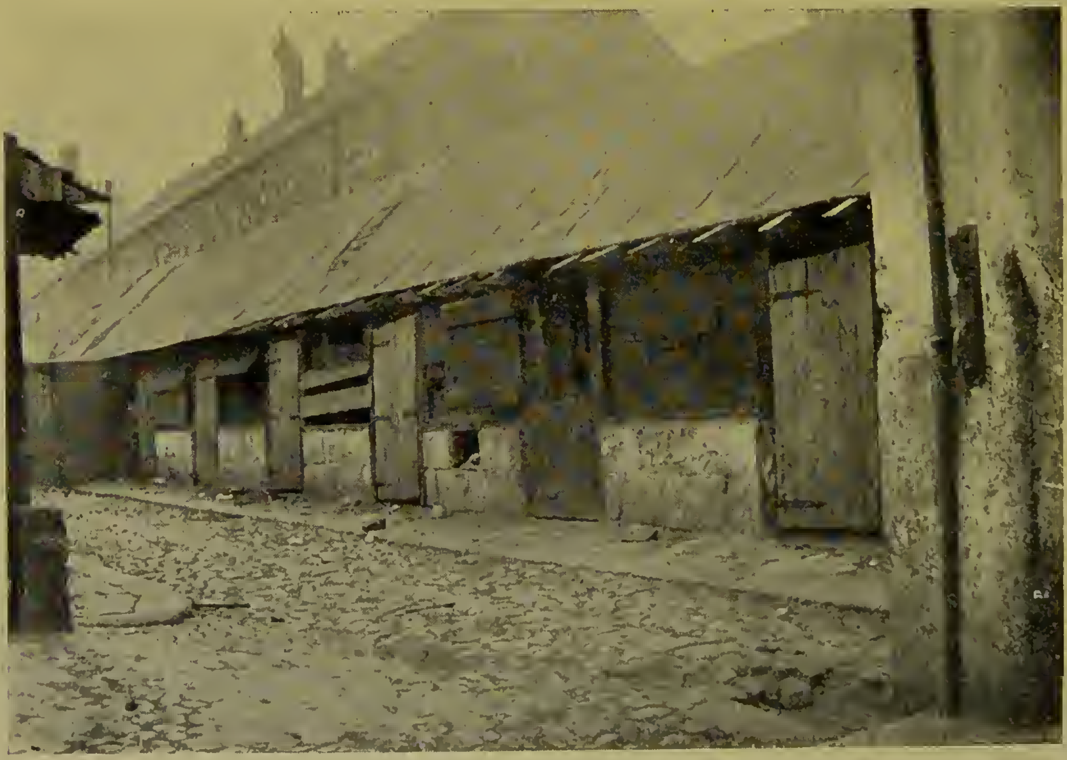
We have at the present day, examples of primitive meat-purveyors' establishments, and they are certainly designed without the slightest

AN OLD-FASHIONED ENGLISH MEAT-PURVEYOR'S SHOP, CONSTRUCTED IN THE EARLY PART OF THE NINETEENTH CENTURY. (SINCE MODERNISED)

Little regard was then paid to ventilation or hygiene, and the roofs were generally constructed very low.

Aberdeen Shambles, showing the Meat-purveyors' Stalls
The shambles formed part of the abattoir.

regard to hygienic requirements. The older shop took the form of a low-ceilinged, congested space, very often on a lower level than the outside street, with a living-room immediately behind, and a slaughterhouse in



Aberdeen Shambles: The Meat-purveyors' Stalls
This type of butcher's stall, attached to the abattoirs, was at one time common all over the United Kingdom. The large shutter over the window was hinged downwards and formed a table for displaying the meats.

Outside View of a Pork-purveyor's Shop at Glasgow

the rear. There are, unfortunately, many such places still in existence, but, as knowledge progresses as to the value which attaches itself to proper construction and plenty of ventilation, it may be supposed that such establishments will gradually disappear

The Old Shambles. One of the earlier forms of meat-purveying establishments was known in many towns as the "Shambles," but this word seems to have been applied indiscriminately to abattoirs and also to meat-shops and this, no doubt, was brought about by the fact that in many places the meat-shops or "butchers' row," as they were sometimes called, very often led from the public abattoir and, in fact, opened

Interior View of Pork-purveyor's Shop at Glasgow from it. Of these old shambles very little remains except the name, but in such places as Leeds, York and Aberdeen, the localities where the old shambles were situated, can still be pointed out, although they have given place to more modern structures.

A notable example of the shambles attached to the public abattoir, was that which existed until recently, at Aberdeen. The meat-shops really formed a part of the abattoir, and the various booths were constructed, to a large extent, of timber. The booths were ranged close alongside one another, thus forming a meat-market in the open. Each of these places was of small dimensions, being not more than about 15 ft. square and about 10 ft. high at the highest point. In order to open them a large shutter extending the whole front of the shop was let down on a hinge and the outside was then supported by means of timber supports, thus forming a rough and ready wooden bench. In these places the cutting up was done on the trunks of trees, sawn either horizontally or transversely, and beech blocks have been known to last in this way for over twenty years, notwithstanding the fact that they were in daily and constant use.

Frozen-meat Importers' Shop

In many towns at the present day, where open markets are held on stated days of the week, such as Nottingham and Leicester, meat-purveyors' stalls form one of the principal features, and these are made by fitting up temporary structures covered over with canvas sheets, and which have to be removed at the end of the day. The right to hold such markets exists in a great many places, but it cannot be said that in so far

English Pork-purveyor's Shop

as the meat-supply is concerned, they are a desirable institution, as in sultry weather, when the dust is flying broadcast, and when there is considerable risk of putrefaction, these open-air and unprotected places offer every opportunity for the speedy decomposition of the meat. It is obvious that, under such conditions, the meat cannot possibly be kept in a cold chamber, and it is therefore constantly running the risk of attracting whatever germs may be present in the atmosphere.

Modern Shops. A modern shop should be located on what is known as the sunny side of the street. This may appear to some to be a very trivial requirement, but it makes just the difference between the successful

American Meat- and Pork-purveyor's Shop

Meat-purveyors' Shop in which the Construction has been Carried Out in Glazed Tiles

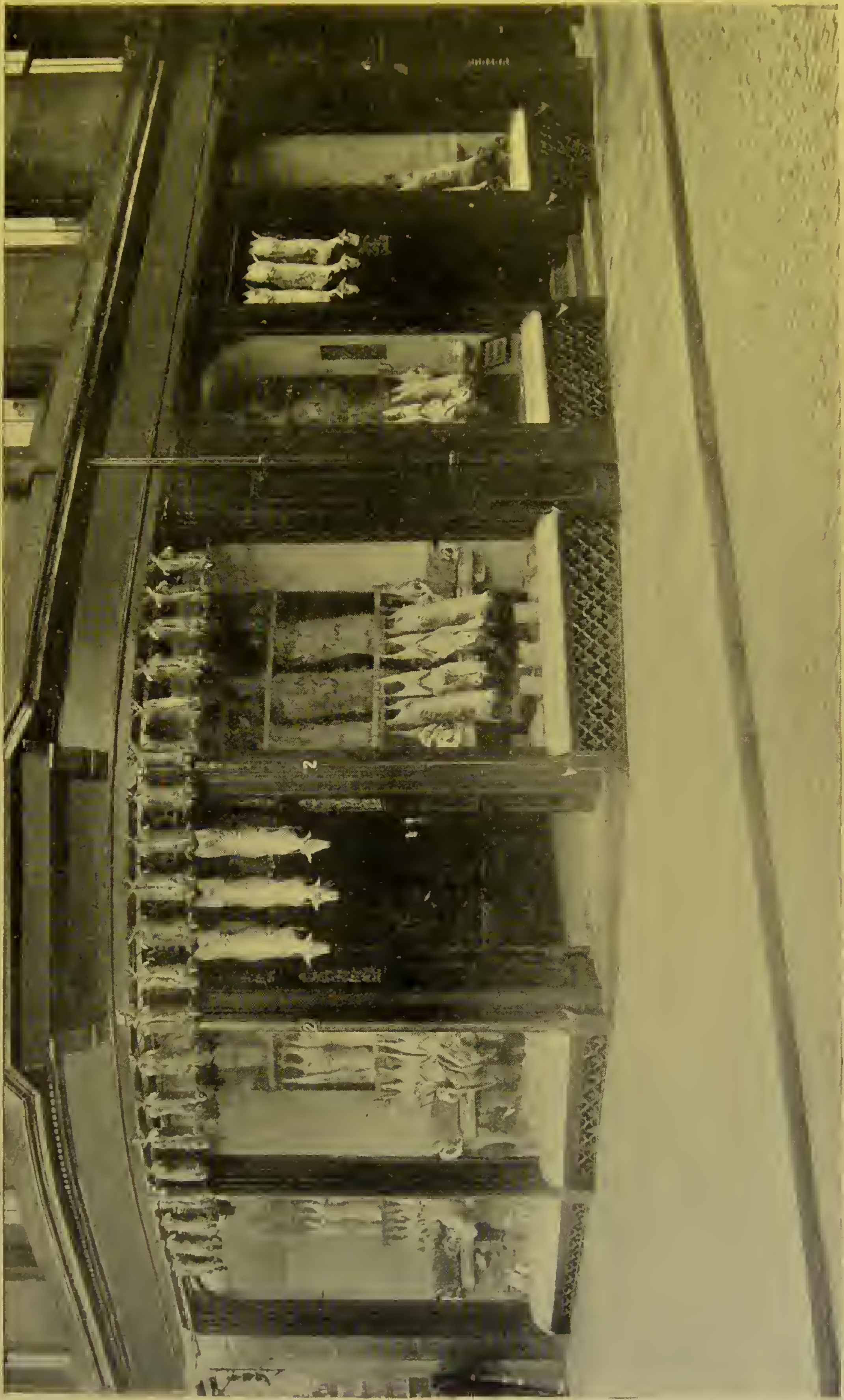
and the unsuccessful business. The choice of a situation for a meat-purveyor's shop is a matter which should receive the very best consideration, whether the business which is contemplated to be carried on is to be on the small or the large scale.

We are bound to assume in discussing a question like this, that there are likely to be many who start out to open a meat-purveyor's business in an extremely small way, and with a small amount of capital. To such, it may be said, that there are certain requirements to which their shop must conform, and there are accessories which they must have, in order to do business at all.

The smallest kind of shop which is permissible in the meat trade is one which has ventilation and plenty of accommodation for the carcases or the meat handled.

In some parts of the United Kingdom, meat is handled in the whole carcase, and this is particularly so in Scotland. It is therefore very difficult to conduct a meat-purveyor's business in that

Meat-purveyors' Shop constructed of Tiling



A Modern Meat-purveyors' Shop (Messrs. Brechin Bros. Ltd., Edinburgh)

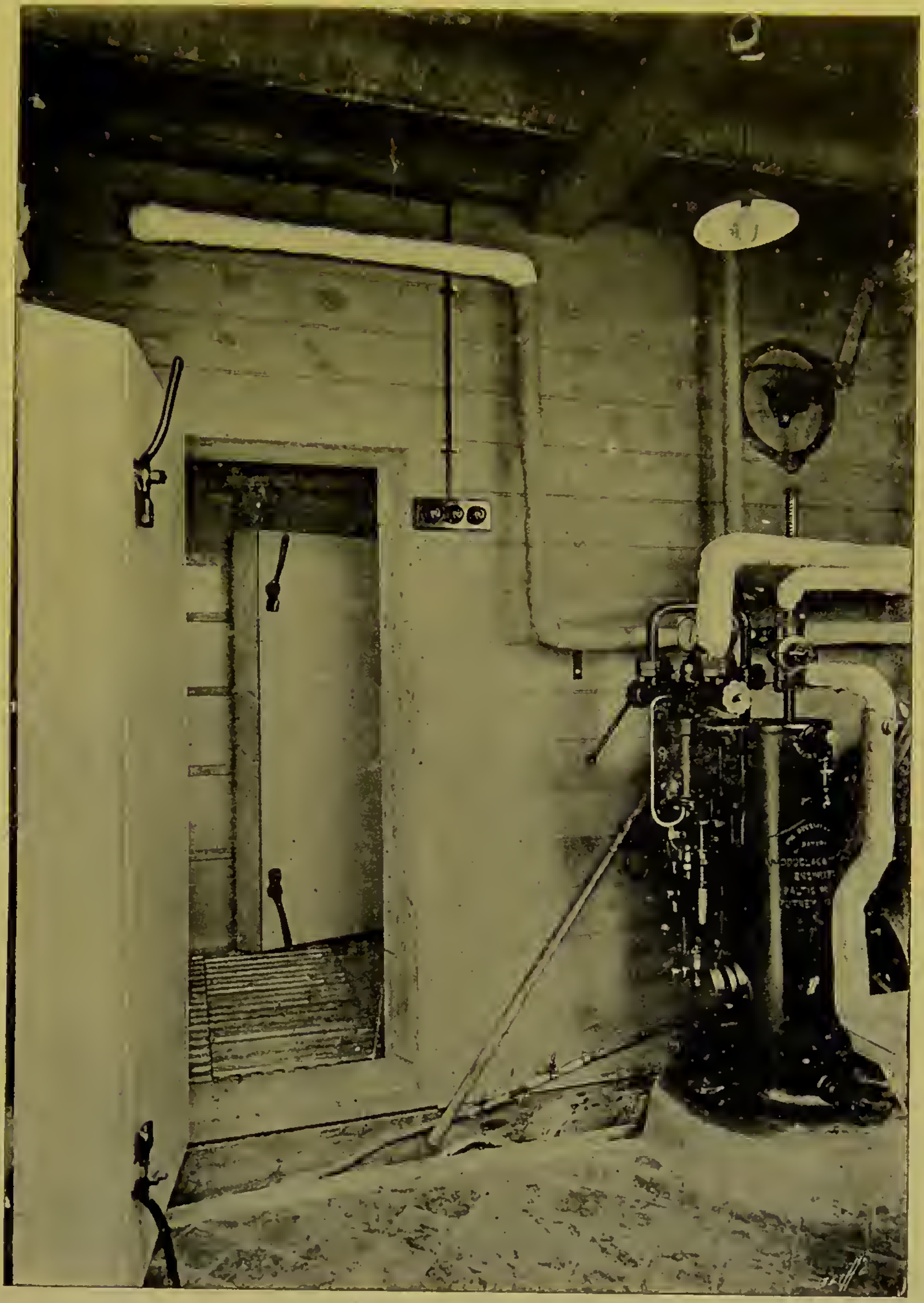
This illustration shows the arrangement of the various branches of the business as carried on in Scotland.

country without having a shop whose ceiling is not at least 15 ft. from the floor.

On the other hand, there are many parts of the United Kingdom where this custom does not obtain and where the carcases of meat are quartered. Where this takes place, it may be said that the height necessary will not be more than about 10 ft. It must not be supposed, however, that because it is possible to handle quarters of meat instead of sides, the ceiling should be just about 7 ft. high, as was the case in many of the older establishments. In a small shop such as we have indicated, it will be necessary to have at least one polished bright steel bar, which should be fixed right round the wall. The dimensions of this bar should be 1½ in. deep by about ½ in. thick, and it should either be fixed on brackets which are attached to the wall, or carried on ornamental columns fixed in the floor. This bar should be at a height of about 7 ft. 3 in. from its bottom edge to the floor, and should be fixed with running hooks, so that quarters of meat and other sections, can be conveniently slung from, and moved from one place to another without much effort.

Requirements of the Modern Shop. In the case, however, where whole carcases are handled, it will be necessary to have a heavy bar fixed on to the ceiling and which may be placed along one side of the shop and also at the bottom end. In order to raise the sides to such a bar, a pulley block over it will be necessary, so that the meat may be slung into position, either at the doorway or in the shop itself. In such towns as Glasgow and Edinburgh, narrow waggons are constructed so that they may be run right into the shop. The carcases of meat are laid on these waggons, and the carcases can be slung into position in the shop, where wanted.

MEAT-SHOP IN JERSEY WITH IRON GRATING IN PLACE OF WINDOW

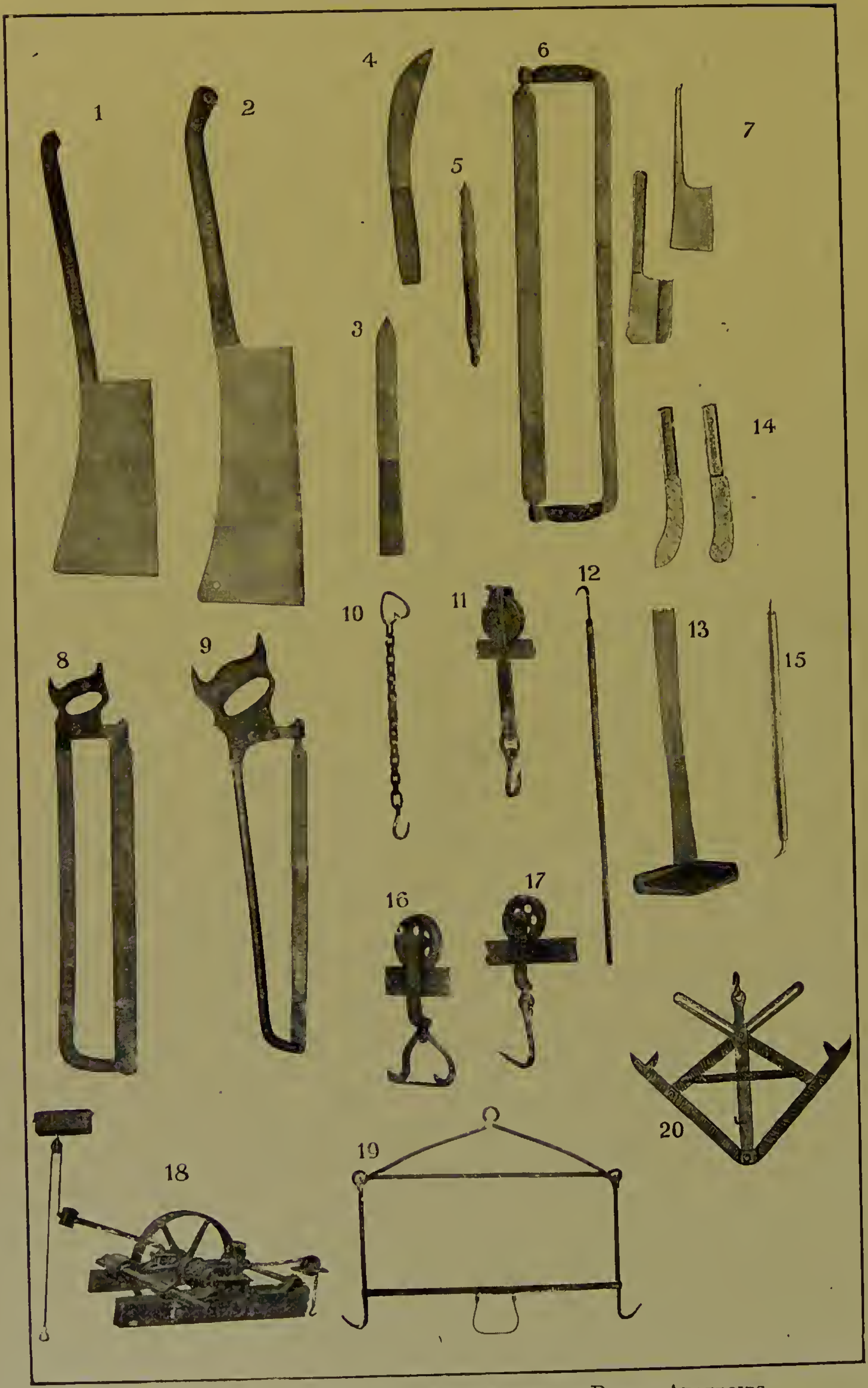


Refrigerating-machine

Part of the modern shop is the cold-room, which is cooled by means of a refrigerating-machine such as is shown in the picture, the room being attached.

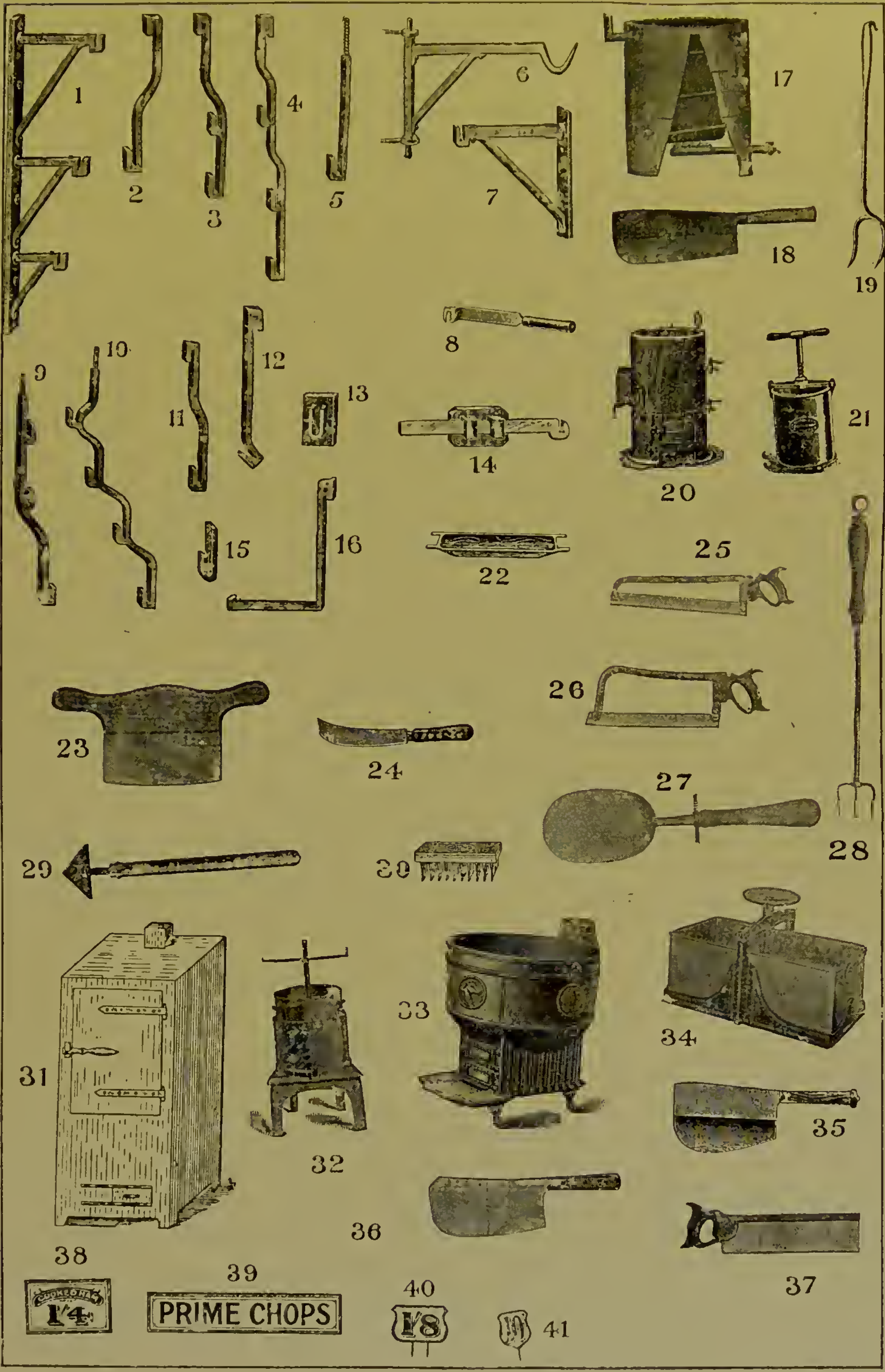
In addition to this bar, there should also be some lighter bars fixed in a convenient position for the hanging of sheep carcases as also for the convenient handling of small pieces of meat of all kinds. It will also be necessary to have bars of ornate design in the windows on which various goods may be shown, so as to attract attention from the outside.

The furnishings of the shop should consist of at least: a French block suitable to the space available and a wall-table made out of a



Some of the Necessary Implements used in Public Abattoirs

1 and 2, beef and pork splitters; 3, sticking-knife; 4, skinning-knife; 5, hickory-gambrel for hogs; 6, beef-splitting saw, without handles; 7, beef-cleavers for splitting down carcases; 8 and 9, beef-splitting and pork-packer's saws; 10 beef-shackle; 11, bleeding-roller; 12, pole-hook; 13, beef-killing hammer; 14, knives for flaying cattle; 15, pritchet for holding up a carcase when lying on floor of abattoir; 16 and 17, track rollers; 18, single beef-hoist; 19, spreading beef-tree (open); 20, beef stang or spreader for hoisting the carcases of cattle.



MEAT-PURVEYORS' APPLIANCES

1–16, various forms of brackets, most of which are for carrying rectangular bars and so designed as to meet the irregularities of different places; 17, gas-heated pan for general purposes; 18, long narrow cleaver; 19, cooking-fork; 20, fire-heated steam-jacketed pan for cooking lard; 21, small lard-press; 22, meat-purveyor's wooden meat-tray; 23, double-handed block-scraper; 24, knife-shaped block-scraper; 25 and 26, bow saws; 27, lard-scoop; 28, window-fork; 29, triangular block-scraper; 30, steel block-brush; 31, portable iron smoke-stove 32, shop lard- or crackling-press; 33, fire-heated plain cooking-copper; 34, brisket-press for cooked briskets of beef; 35, Smithfield chopper; 36, short cleaver; 37, back saw; 38–41, different forms of show tickets.

marble slab, running along one side of the shop. Tiling should be universal, as the presence of the bacteria, which always follows meat wherever it is handled, is to a large extent minimised by the use of impervious material in the construction of the ceiling and walls. The walls should be tiled and the window should be also either tiled or fitted with a large marble slab. In so far as the floor is concerned, this should be constructed with some impervious material which can easily be cleansed from day to day.

The necessary tools in a small shop should consist of: A steelyard or steel beam for weighing carcases; a set of pulley-blocks for raising meat to bars; a good set of counter scales; an assortment of cutlery, consisting of one bone-saw, one back-saw, a good chopper for carcases, a lamb-chopper for lighter work, two shop knives, two boning-knives, a steel, a block-scraper, two butchers' trays, a small pickling-pump and such cleansing utensils as brushes, a pail, &c.

It is also desirable in a small shop, as in a large one, to have a recording till, so that all the takings can be checked.

In such a business, where the turnover may be up to £50 per week, there will be a considerable amount of small dealing, and hence it will become necessary to have a cold-chamber, so as to maintain the meat in a perfectly fresh and wholesome condition. Small cold-chambers are made nowadays to suit every business, and in no section of the meat trade are they more essential than in the small shops. A small shop may not be able to afford a mechanical refrigerator and indeed it would be out of proportion altogether to the turnover, but it will always be possible to have a small cold-room, and it will be for the shop owner to gauge to what extent this room will be necessary. A small cold-room may be had, measuring 4 ft. 6 × 3 ft. 6 × 7 ft. high outside, and as these rooms are usually constructed of insulating material and lined with zinc, they are admirably suited for small businesses. They can be kept fairly cool, namely, at a temperature of from 42° to 44° Fahr. by an expenditure of 2 to 3 cwts. of ice per week.

It is very important also that in connection with such a shop there should be a cellar or a nice cool back room where pickling can be conducted. There is a constant demand for pickled beef, pork, tongues, &c., and as they offer a ready source of income to the small purveyor, they should certainly be provided for.

Hints to the Small Dealer. In the small way it is possible to do a good deal of pickling in a single thirty-gallon oak-pickling tub of the circular type, such as are now common. It is better, however, to have a number of these tubs so that the pickling may be controlled and fresh pickle made whenever it is wanted, without disturbing the goods in pickle. The pickling cellar or chamber should be a cool, well-ventilated dark place and should be kept scrupulously clean. In fact, it should be lime-washed periodically, so as to keep it nice and sweet. The pickle can be made from the following recipe:

55 lb.	salt.
5 ,,	saltpetre.
5 ,,	cane sugar.
5 ,,	dry antiseptic (boron preservative).

This quantity should be *made up to* twenty gallons and boiled until quite clear. It is then allowed to cool to the temperature of the curing-apartment and should then test on the salinometer about 100°. The salinometer is just a convenient method of arriving at the density of the liquid, and it takes the place of the ancient method of finding the same thing by floating a potato or pig's foot. About 100° on the salinometer indicates that the solution is saturated. That is to say, it will not hold any more salt, and any attempts to make it hold any more will simply result in that material crystallising out.

Another convenient portion of the small shop is the sausage department.

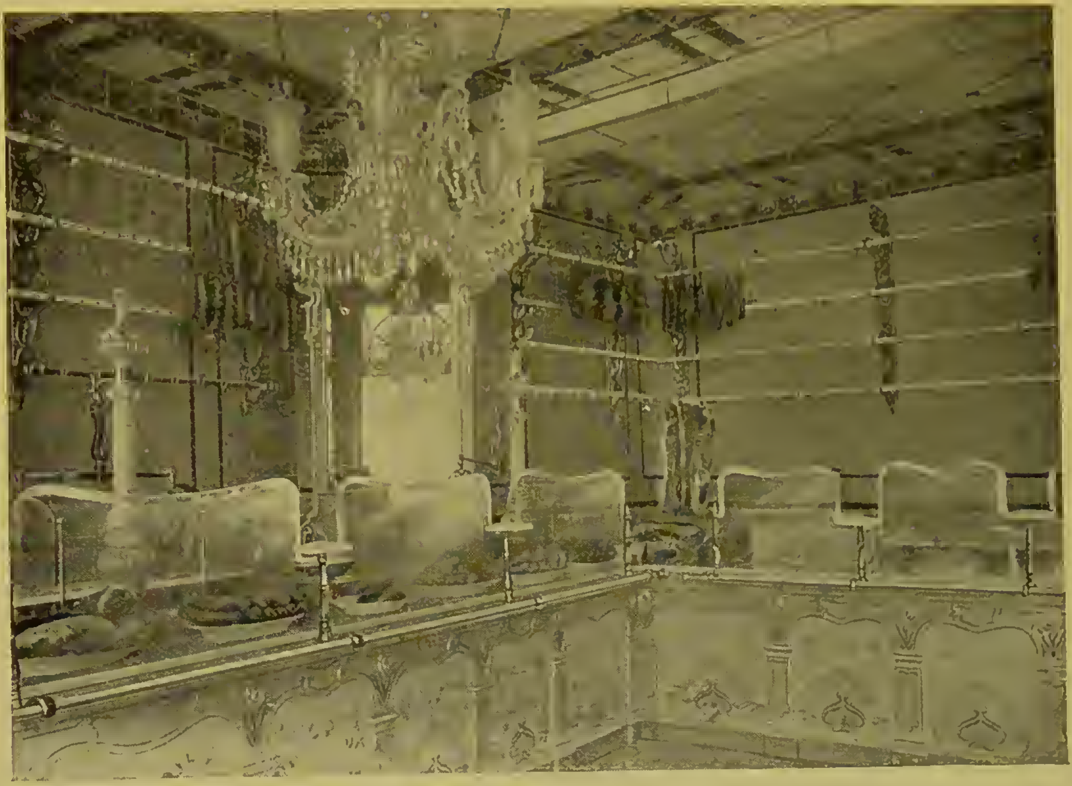
Making sausages in the small way is a necessity of meat-purveying, as there are many oddments which lend themselves to being worked up in this way. Thus, pieces of meat which are perfectly fresh and wholesome, but in their condition are unsaleable, are best converted into sausages and this can easily be done. The equipment for this purpose consists of a small hand sausage-machine and a sausage-filler, both of which can either be fixed in the shop itself, or in the back premises if there is room. We will deal with the recipes for sausage-making at a later stage (*see* Chapter VII.).

In speaking of the small meat-purveyor's shop, we have assumed that there will be no slaughterhouse attached. The tendency everywhere at the present day is towards large abattoirs, and it may be assumed that in a few years' time private slaughterhouses will be entirely abolished. Abattoirs (which are described in their place) play an important part in the hygiene of the country and are the only perfect means by which the distribution of diseased meat may be avoided. The creation of public abattoirs has, however, also given rise to wholesale meat-markets and these are not only patronised by the small meat-purveyor, but are a source of great convenience to the large purveyor also, as in these meat-markets it is possible for a shopkeeper who may have a special trade, to purchase exactly what he wants, leaving the remainder to other shopkeepers who may have a different class of business entirely.

Large Shops. There are many handsome designs of large meat-purveyors' establishments, and these naturally classify themselves into meat-purveyors' shops and pork-purveyors' shops.

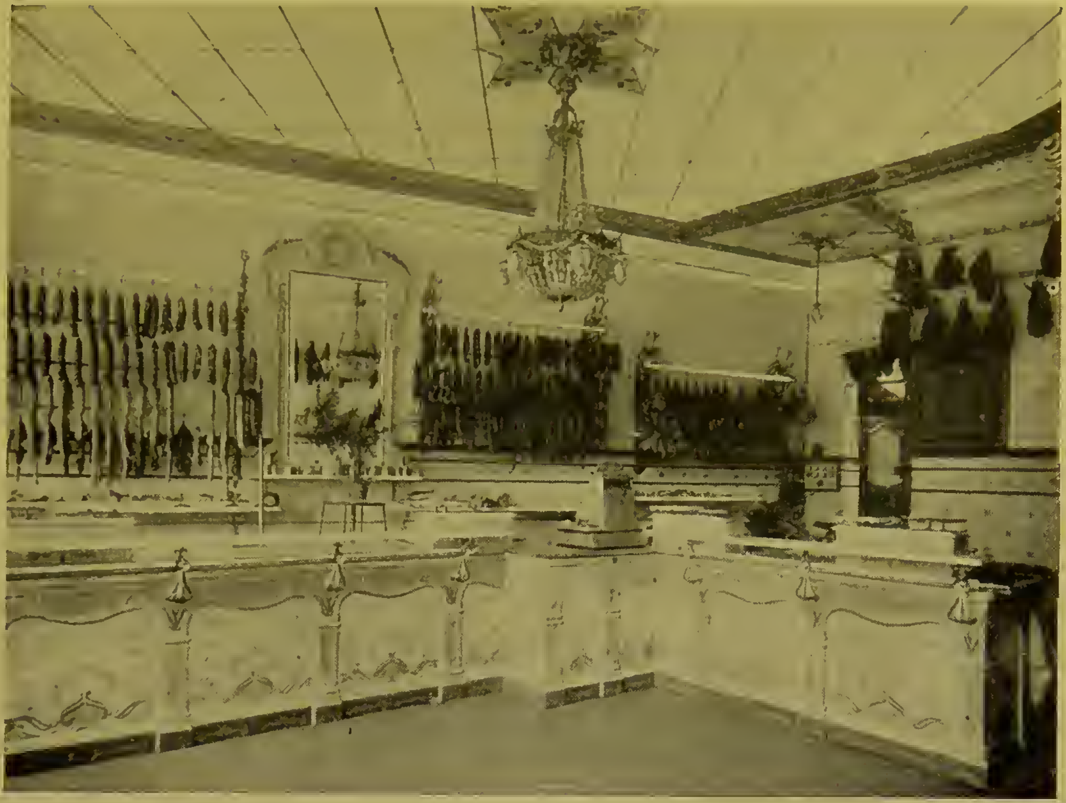
The first of these may lend itself to elaborate design and, as will be seen from the illustrations, they sometimes involve a considerable outlay of capital.

The establishment of a large meat-purveyor's shop depends entirely upon the situation, but the ideal establishment is unquestionably at the corner of a busy thoroughfare. If possible, there should be a number

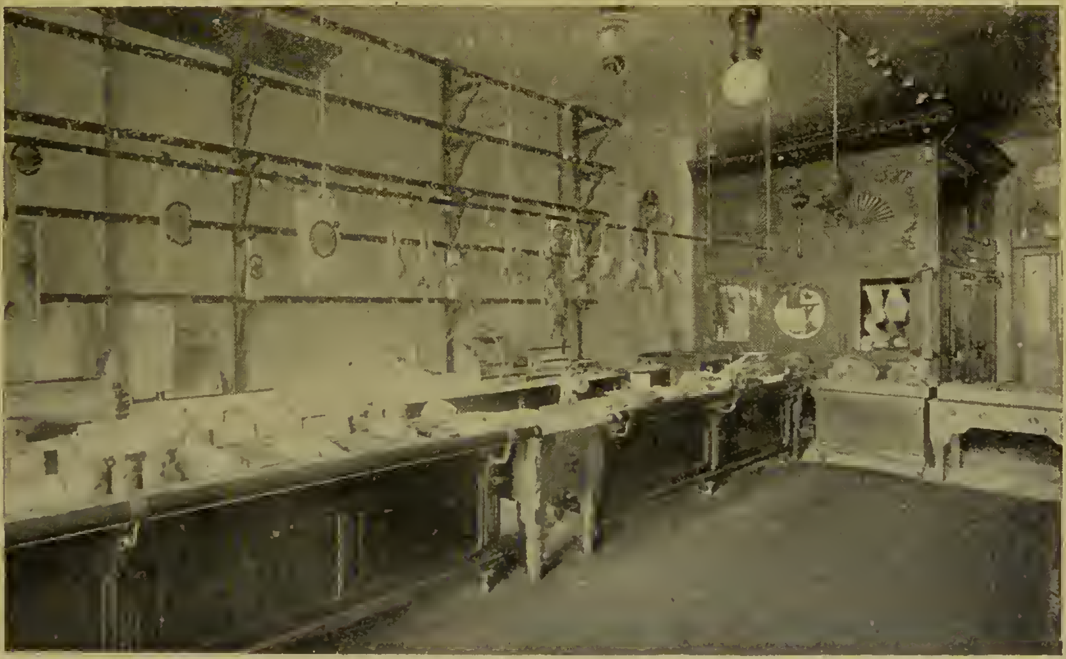


German Pork-purveyor's Shop

American Meat- and Pork-purveyor's Shop, showing the Refrigerating-chamber in Corner



German Pork-purveyor's Shop



American Meat- and Pork-purveyor's Shop, showing the Ornate Design of Cold chamber in Corner of show windows in such a shop, and these can be devoted to the various kinds of meat which are handled, as also to poultry, game, &c., when such may be in season, as it is the usual custom amongst the larger establishments to deal in these articles.

In the large shop it will be necessary to have plenty of space devoted to cutting-up blocks and these should be of the very best material, such as is provided by the French hornbeam variety. The meat should be hung also in such a way as to be quite clear of the traffic in the shop itself and where carcases are handled, these should be suspended from heavy track-bars. Lower bars should also be provided so as to hang quarters, sheep, pigs and sections of meat, but it is common in some large shops to provide special light bars (1½ in. × ½ in.) for the carrying of mutton carcases.

Interior Arrangements. At the present day the arrangement in the interior of a first-class meat-purveyor's shop has been reduced to pretty well understood rules. That is to say, there should be plenty of ventilation and abundance of light. The walls should be covered with tiles or should be constructed with enamelled bricks. The ceiling should be tiled over and the floor should be of impervious material.

An office should also be provided in such a convenient position that it will command the whole of the traffic in and out of the shop, and, in order to expedite trade, all payments should be made at this office, the assistants not being required to do anything except cut up the meat.

In a large establishment such as we have indicated, there will, of necessity, be commodious rear premises, devoted to sausage-making and the pickling of meats. In many cases there will be a private abattoir as well, but that need not be referred to here. The equipment for the sausage-making room will have to be proportioned to the size of the trade, but it will be necessary to have either an electric motor, a gas-, or steam-engine, together with a power sausage-cutter. A fairly large sausage-filling machine will also be necessary, and this department should be fitted up with a full assortment of tables for the boning of meat and the cutting of it up into portions, previous to converting it into sausages.

The pickling-room could, if possible, be in the cellar and should be maintained in a perfectly sweet and fresh condition, and it should be a rule that the pickle should be examined from time to time, to see if it is perfectly sweet.

In the Pickling-department. The making of this pickle is a very important matter and it should always be seen that it has a constant density, by the use of the salinometer, which has been already referred to.

In a large establishment there will be a considerable number of different pickling-vats and these can either be constructed of slate, concrete, or be built of oak staves ; local conditions must always regulate such a matter. Portable pickling-tubs of oak staves are very handy and they can be taken outside and cleansed at any time, should they, by any misfortune, become foul. The sizes in which they are usually made are 20, 25, 30, 35, 55 and 90 gallons, and they are supplied with a perforated lid which can be placed on the top of the pickle and weighted down so that the meats which would otherwise be inclined to float on the surface of the pickle will be kept constantly submerged.

As has already been stated, the pickling-room should be cool and always kept in a perfectly clean condition. Ordinary sunlight should be excluded as far as possible, and artificial light used, owing to the darkening effect which the rays of the sun have upon lean portions of meat. A dark curing-cellar has besides, the advantage of not being attractive for flies. Plenty of ventilation is, of course, necessary in such a place.

Different Types of Shops. In different countries the shops follow various designs and in some cases these are of a very elaborate character, more especially in Germany and America. Throughout the meat-trade, however, there has been a strong tendency in recent years to adopt highly ornamental fittings, which not only show off the goods to advantage but undoubtedly attract custom.

In America, where there are such variations of design, the leading feature in every meat-shop or meat-market, as it is called, is the refrigerating store or cold-room, and it would hardly be possible to conceive of a market which had not a cold-room, as an essential part of its equipment. These cold-rooms are not only worked with ice, but they are also in a great many cases attached to refrigerating machinery, and they are so situated as to be convenient to the shop. In many cases, the side or the front of the cold-room is composed of thick plate-glass, which takes the place of the insulation. The plate-glass is fitted into the cold-room double, so that an air-space between the two sheets of glass is provided, and as this air-space is perfectly still, it becomes an insulator. The advantage of the plate-glass, however, is to show the class of goods that are kept; it also possesses the advantage that it enables the purchasers to indicate what they want, in hot weather.

Mirrors are largely used in the United States for the decoration of shops, and the style of hanging the goods is different from that which obtains in any other country. Heavy pieces of meat are not so much in evidence, the work of cutting these up being performed, either in the rear premises or, in the wholesale supply establishments. Sausage and pork shops are, of course, much in evidence and the class of goods that are offered are more after the German *charcuterie* style, the variety of sausages produced being pretty much on the lines of those made in Germany. This is the result of the large German population, and it also shows that the high-class goods which are produced in the German pork shops have only to become known to be generally appreciated. There are also general markets or shops in the United States in which a great variety of goods are handled, such as meat and pork products, including fresh meats, cured meats and vegetable provisions. These shops, however are not general outside of America.

The German Shops. Of equal interest with the American establishments are those which are found in Germany and which present characteristic features not found anywhere else. The meat-purveyors' shops, in Germany do not differ to any great extent from those in other countries, but there is a wide difference noticeable in so far as the pork-purveyors' establishments are concerned. Many of these are lavishly designed, and the fittings are of a high order. The walls of such shops are covered with ornate tiling, as are the ceilings; the floors also are completed with mosaic or some similar material. The feature, however, which attracts the most attention in these German shops is the special design of counters. These are built up either of marble slabs with brass or aluminium fittings, or they may be constructed of elaborately designed encaustic tiling. It is common in some of them to have large plates of glass arranged along the fronts of the counters, so that the goods which are lying there may be quite easily seen without being handled.

It will be understood that these German shops are more specially devoted to *charcuterie*, which is a general term that embraces the manufacture and sale of such goods as sausages, hams, bacon, galantines and special preparations of a similar character. These goods are very extensively manufactured and sold all over Germany, and more especially in the cooked state. The number of recipes in use for sausage-making alone runs up to between seventy and eighty, and from this fact it will be understood that such a great variety necessarily involves considerable skill in the manufacture. The shops are also specially fitted with small hanging bars and diminutive hooks so that the various goods may be hung from them in an attractive display. These German shops are generally complete in themselves. That is to say, they consist of the main shop where goods are sold and a large workroom or workrooms in the rear, and the special feature is the smoking-stoves which are very much used for many different kinds of sausages and other products, smoked goods being much in favour in Germany. In so far as pickling and slaughtering are concerned, these are pretty generally conducted under official supervision at public abattoirs.*

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* *See* "Public Abattoirs and Cattle Markets," from the German of Oscar Swartz, edited by G. T. Harrap and Loudon M. Douglas. Third edition, 1901.

CHAPTER VI

THE CONTROL OF THE MEAT-SUPPLY

There is a control of the meat-supply which does not lie so much within the province of meat inspection as it appeals more to the farmer and the meat-purveyor and concerns itself with the kind of meat which is to be sold in this country. It will be understood that this remark applies solely to the United Kingdom, which seems to be the central dumping-ground for the various meat-producing countries in the world.

In a previous chapter it was clearly shown to what an extent we are indebted for our meat-supplies to foreign nations and it would appear from the available statistics, that the home produce is on the decline. This is, perhaps, not so, in so far as pedigree stock is concerned, as in that branch of husbandry the British nation seems to be able to hold its own with any country in the world, and the highest prices for pedigree stock are always realised in the United Kingdom. It might be inferred that when foreign nations come to the United Kingdom in order to obtain pedigree stock they do so with the full knowledge that if much money is thereby expended, they will ultimately get it all back in increased markets for their meat products. It may therefore be taken that in a general way there is little movement towards increasing the supplies of home-bred live-stock for the meat trade, and the total supply in the United Kingdom at our weekly live-stock markets is only a trifling part of what is consumed in the country.

As an illustration of this, it may be stated that, thanks to the initiative of the Board of Agriculture, a number of excellent returns are provided in connection with the sale of live-stock, and some of these give the numbers of fat cattle, sheep and pigs, which are entered for sale at some fifty-one typical live-stock markets throughout Great Britain. The latest available returns are shown in the Table on pp. 492–3 and if the grand total is compared with previous years, it will be seen that the numbers at these markets do not vary very much from year to year, the tendency, if any, being downwards.

Fat Cattle and Swine. The fat cattle, as will be seen, which were presented at these markets, total up to 1,029,978, and at these places it is interesting to note, that within the same period the total number of fat sheep entered was 3,764,695, and fat swine 700,621.

It is remarkable also that during the year 1909 there came about quite an abnormal condition of affairs in connection with swine husbandry. The shortage in Great Britain alone was reckoned at

NUMBER OF FAT CATTLE RETURNED AS ENTERING CERTAIN BRITISH MARKETS AT THE UNDERMENTIONED PLACES IN EACH MONTH OF 1908

Places.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.	Places.
ENGLAND AND WALES.														ENGLAND AND WALES.
Ashford .	628	623	446	476	620	449	530	748	539	520	514	387	6,480	Ashford.
Birmingham.	459	560	524	547	754	397	455	500	411	477	500	329	5,913	Birmingham.
Bridgnorth .	202	212	222	294	403	241	215	174	134	225	143	179	2,644	Bridgnorth.
Bristol .	1,195	1,484	1,236	1,131	1,160	863	951	1,296	1,020	1,431	1,084	891	13,742	Bristol.
Caerwys .	16	15	—	36	8	—	15	6	—	18	10	9	133	*Caerwys*.
Carlisle .	1,278	1,407	876	830	1,135	764	913	1,291	1,237	1,165	945	1,370	13,211	Carlisle.
Chichester .	346	537	348	390	398	412	353	566	744	332	360	349	5,135	Chichester.
Corwen .	41	42	49	27	18	—	15	12	14	42	20	66	346	*Corwen*.
Crewe . .	850	1,040	828	802	930	760	659	672	722	909	806	870	9,848	Crewe.
Darlington .	734	1,090	870	799	980	705	777	977	814	882	716	577	9,921	Darlington.
Denbigh .	65	41	30	68	34	54	46	30	24	21	46	79	538	*Denbigh*.
Derby . .	2,485	2,192	2,382	3,300	2,573	2,807	2,740	2,072	2,091	2,716	2,201	2,405	29,964	*Derby*.
Dorchester .	327	309	320	397	338	288	367	290	326	409	290	507	4,168	*Dorchester*.
Exeter . .	604	599	630	517	220	258	634	648	552	588	483	395	6,128	*Exeter*.
Gateshead .	932	1,293	967	961	1,411	974	879	927	864	890	794	1,308	12,200	Gateshead.
Hereford .	1,252	1,635	1,365	1,550	1,835	1,599	1,432	1,759	1,036	1,441	1,233	1,268	17,405	Hereford.
Hull . .	1,701	1,468	1,564	2,104	1,727	1,673	1,956	1,640	1,691	2,012	1,511	1,375	20,422	*Hull*.
Ipswich .	1,045	896	1,008	1,615	1,371	1,344	1,415	1,059	1,051	1,093	869	1,218	13,984	*Ipswich*.
King's Lynn.	1,213	2,221	2,464	2,902	4,123	2,225	1,139	991	789	899	654	881	20,501	King's Lynn.
Leeds . .	2,866	3,499	3,239	3,257	4,604	3,165	2,683	2,968	2,406	3,007	2,466	2,185	36,345	Leeds.
Leicester .	1,865	2,458	2,163	2,407	2,867	2,321	2,157	3,266	3,251	4,271	3,335	2,147	32,508	Leicester.
Lincoln .	403	624	513	603	697	562	623	760	618	706	446	349	6,904	Lincoln.
Liverpool .	4,227	4,499	3,346	2,996	2,617	1,435	2,487	4,689	4,436	6,232	6,230	4,965	48,159	Liverpool.
London .	4,850	5,210	3,645	3,870	5,360	3,980	3,380	5,020	4,170	5,640	4,930	5,425	55,480	London.
Newcastle .	6,407	8,745	7,297	7,371	9,541	7,691	7,318	9,589	7,459	9,298	7,902	7,518	96,136	Newcastle.

Newport .	1,210	1,132	1,179	1,707	1,365	1,131	1,414	969	976	1,432	1,225	1,332	15,072	*Newtort.*
Northallerton	895	1,012	828	855	1,037	755	789	1,234	1,039	1,392	1,005	894	11,735	Northallerton.
Norwich .	2,318	4,165	4,544	5,915	8,033	3,761	879	597	523	552	652	693	32,632	Norwich.
Oswestry .	1,171	1,359	1,315	1,182	1,679	1,327	944	1,163	985	1,232	909	1,105	14,371	Oswestry.
Peterborough .	378	390	395	499	390	844	1,300	635	595	579	357	622	6,984	*Peterborough.*
Ruthin .	68	130	62	80	73	59	19	32	21	39	23	84	690	*Ruthin.*
Salford .	8,620	10,366	7,739	7,759	8,353	5,636	5,965	8,493	7,808	10,129	8,459	8,608	97,935	Salford.
Selby . .	385	591	466	553	793	514	312	255	254	355	191	182	4,851	Selby.
Shifnal .	164	425	364	298	452	466	343	290	159	100	116	209	3,386	Shifnal.
Shrewsbury .	897	1,185	949	1,013	1,289	1,030	726	900	749	918	503	1,108	11,267	Shrewsbury.
Stokesley .	136	128	143	186	227	169	170	153	166	260	170	124	2,032	Stokesley.
Wakefield .	3,726	3,976	3,170	3,491	4,635	3,312	3,558	4,586	4,015	4,878	4,720	3,954	48,021	Wakefield.
Wellington .	1,307	1,684	1,542	1,871	2,443	1,902	1,571	1,532	1,053	1,285	891	1,189	18,270	Wellington.
Wolverh'mpt'n	2,141	2,381	2,435	2,323	3,077	2,010	1,876	2,400	2,019	2,723	2,104	1,784	27,273	Wolverhampton.
York . .	1,002	1,333	1,120	1,272	1,376	1,105	940	1,237	1,018	1,358	931	906	13,598	York.
Total .	60,409	72,956	62,583	68,254	80,946	58,988	54,945	66,426	57,779	72,456	60,744	59,846	776,332	Total.
SCOTLAND.														SCOTLAND.
Aberdeen .	2,267	3,017	2,160	2,155	3,302	3,264	2,063	2,369	1,798	2,334	1,744	2,587	29,060	Aberdeen.
Ayr . .	1,504	2,011	1,663	1,492	1,651	1,457	1,413	2,394	1,608	1,916	1,502	1,746	20,357	Ayr.
Castle Douglas	430	758	1,225	889	780	400	341	358	273	321	291	437	6,503	Castle Douglas.
Dingwall .	377	545	392	483	486	329	408	517	340	331	368	527	5,103	Dingwall.
Dundee .	976	1,356	1,155	1,263	1,767	1,273	1,013	1,205	945	1,202	961	963	14,079	Dundee.
Edinburgh	2,958	1,909	1,806	3,505	4,490	3,464	3,543	4,126	3,420	4,624	3,629	3,520	40,994	Edinburgh.
Elgin . .	673	1,065	1,044	1,224	1,361	856	594	655	641	424	387	574	9,498	Elgin.
Glasgow .	6,706	8,520	5,938	6,634	8,022	6,023	4,484	6,509	5,789	8,092	7,018	7,900	81,635	Glasgow.
Inverness .	675	936	1,009	1,190	739	664	788	583	528	559	484	720	8,875	*Inverness.*
Perth . .	1,512	1,981	2,445	2,770	3,773	2,538	1,692	2,044	1,246	1,362	1,059	1,457	23,879	Perth.
Stirling .	893	1,488	1,018	1,057	1,257	1,102	995	1,381	1,071	1,271	981	1,149	13,663	Stirling.
Total .	18,971	23,586	19,855	22,662	27,628	21,370	17,334	22,141	17,659	22,436	18,424	21,580	253,646	Total.
Grand total	79,380	96,542	82,438	90,916	108,574	80,358	72,279	88,567	75,438	94,892	79,168	81,426	1,029,978	Grand total.

NOTE. The numbers for the places printed in italics are those returned by the Market Reporters of the Board; the remainder are returned under the Markets and Fairs (Weighing of Cattle) Act, 1891.

442,595 or 15.7 per cent. below the numbers returned in 1908, but this latter result was also co-incident with a general shortage in the pig-markets throughout the world, and more especially in the United States, where the shortage of the corn or maize crop reduced the number of swine very considerably. At the same time, there was a general shortage of swine throughout the various bacon-curing countries which, so far as could be seen, was not due to any apparent cause.

In this connection it is of interest to turn aside for a moment and examine the figures which are available with respect to the largest meat-market in the United Kingdom, namely, The Central Markets, Smithfield, London. The total supplies at Smithfield Market for 1907 and 1908 are shown in the following Table:

COMPARISON OF SUPPLIES DURING 1908 AND 1907 AT SMITHFIELD MARKET, LONDON

Source of Supply or Classification.	1908.	1907.	Difference.	Rate per cent.
	Tons.	Tons.	Tons.	
United Kingdom . .	88,262	85,861	2,401 increase	2.7
North American "English-killed" .	54,691	67,107	12,416 decrease	18.5
United States and South American "chilled" and "frozen" . .	106,944	102,129	4,815 increase	4.7
Continental . .	58,509	54,388	4,121 ,,	7.5
Australasian . .	101,326	107,572	6,246 decrease	5.8
Total meat, poultry and provisions	409,732	417,057	7,325 decrease	1.7

The report of the superintendent of the markets states that beef and mutton constitute the great bulk of the commodities dealt with at the market. The marketing of such products bred in the United Kingdom has but slightly increased. It is of interest to notice the ratio of supplies, and this is given in the following Table:

TABLE OF ANALYSIS OF SUPPLIES OF BEEF, MUTTON AND PORK AT SMITHFIELD MARKET, LONDON, DURING 1908

Classification.	Beef.	Ratio per cent.	Mutton.	Ratio per cent.	Pork.	Ratio per cent.	Miscellaneous.	Ratio per cent.	Totals.	Ratio per cent.
	Tons.		Tons.		Tons.		Tons.		Tons.	
British produce .	37,354	18.4	23,932	18.4	14,000	35.2	12,976	35.3	88,262	21.5
Colonial & Foreign Produce . .	165,822	81.6	106,145	81.6	25,750	64.8	23,753	64.7	321,470	78.5
Totals . .	203.176	100.0	130,077	100.0	39,750	100.0	36,729	100.0	409,732	100.0

Nearly 40 per cent. of the beef arriving at these markets comes from the United States, and of the total quantity of produce, namely, 409,732 tons, dealt with in the poultry and provision sections during 1908, only 88,262 tons or 21.5 per cent. were bred and slaughtered in the United Kingdom, thus leaving 78.5 per cent. to be imported from other countries. As showing what this really means, it is of interest to quote another Table, which is given in the report. It illustrates the gradual change which has taken place in the sources of supply of the food of Greater London :

Table Showing the Total Meat-supplies at Smithfield Market, London, during thirty years—1877–1908—and the gradual transition from home supplies to foreign

Period.	* Produced or Killed in the United Kingdom.	Imported Fresh killed, Chilled or Frozen.	Proportion in terms per cent.		Totals.	Increase on Previous Period.
			United Kingdom	Im-ported.		
	Tons.	Tons.			Tons.	Rate %
1877–1881	904,495	145,579	86.1	13.9	1,050,074	30.8
1882–1886	923,902	239,026	79.5	20.5	1,162,928	10.7
1887–1891	932,623	472,670	66.4	33.6	1,405,293	20.8
1892–1896	920,474	788,750	53.9	46.1	1,709,224	21.6
1897–1901	877,331	1,147,434	43.3	56.7	2,024,765	18.4
1902–1906	818,090	1,250,587	39.5	60.5	2,068,677	2.1
1907	152,968	264,089	36.7	63.3	417,057	—
1908	142,953	266,779	34.9	65.1	409,732	—
Totals .	5,672,836	4,574,914	55.4	44.6	10,247,750	

These figures are given in some detail because they illustrate how much of the surplus meat produced in the world finds its way to the London markets, so as to supply the wants of, at least, 7,000,000 people in that great city.

Meat Inspection at Ports. But these figures are of quite another interest besides, as they show that the conditions under which meat must be controlled in the future are gradually undergoing a significant change, and provision must be made for inspection at our ports of all meat which is brought in and, in appreciation of these circumstances, it it satisfactory to know that the Local Government Board have issued instructions to all Port Sanitary Authorities † and others concerned, providing for the examination of all meat products at ports of entry. These regulations came into operation on January 1, 1908, and have already had a salutary effect in preventing the landing in Great Britain of questionable meat.

Another point presents itself in connection with this matter, which in itself is serious enough.

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* Includes products of imported live foreign cattle landed and slaughtered in the United Kingdom.

† *See* Vol. V.

The trend of events, as we have seen, shows that the meat industry in the United Kingdom in, the future must, to a large extent, consist of the buying and selling of dressed meats imported from overseas, and this means that the by-products of the business which form such a large portion of the profits will not be manipulated in this country at all. This in itself is an unfortunate state of affairs, as it means the loss of a huge amount of capital to the country year by year.

The Value of Meat Products. It is only right to say that many foreign nations which lay themselves out for supplying British markets with meat products have developed the handling of these products to such an extent that little is wasted, and every part of an animal is put to some use. Chemistry and scientific knowledge have been utilised in the conversion of meat products into specialised articles, which on being added to the prices obtained for the carcases pure and simple, makes it possible for these to be landed on our shores at a much smaller price than it pays to grow them here.

This, therefore, is a point of view which must be borne in mind in the future development of the meat industry in the United Kingdom, and it rests with the meat-purveyor and the farmer to say whether they, in combination, will permit the growing of live-stock, which is the principal pursuit in connection with agriculture, to be gradually supplanted by supplies of meat products from overseas.

Reverting for a moment to the methods in use in foreign countries in connection with the marketing of meats, it must be acknowledged that there is much room for improvement in the United Kingdom. In the United States, for example, the transport of meat is invariably regulated by the large abattoir and packing-house owners, who not only make rigid stipulations with the various railway companies as to refrigerator cars for their meat, but in many cases provide such cars themselves, so that the meat, which is handled in the abattoir, can be chilled and transferred to a refrigerating waggon which is loaded up with a freezing mixture of ice and salt so as to preserve a low temperature during transport, and the meat may then be carried from the abattoir to the cold-room or refrigerated chamber in the shop. Such are the ideal conditions, and these could be imitated in many ways in the United Kingdom. The transport of dead meat from abattoirs to distant shops is a matter which requires a great deal of development, and which also involves a fuller appreciation by the meat-purveyor of the value of cold storage, not only in the keeping of his meat but also in the maturing of it.

As we have already mentioned, there are many interesting features in overseas countries, where the handling of the animal has been organised and divided up into various departments. The meat inspection itself is, with the full consent of the abattoir owners, under the complete supervision of the Government veterinary officers, who are assisted in every possible way in their inspection of live animals and dead meat. Beyond that, however, the by-products of slaughtering now form an immense industry, more especially in the United States, and the development of this branch has been quite phenomenal.

Other Profitable By-products. To mention only the principal items which are handled under the heading of by-products, it may be said that the chief is that of the hides, which are so carefully graded as to be put into various classes or values. Arrangements are made for the keeping of these hides from two to six months in salt, so that the quantities stored are sometimes enormous, and although the salted weight shrinks to about one-sixth of the unsalted hide, it is sometimes profitable to keep hides that length of time. To quote an authoritative publication on this matter : *

" Next in importance are the fats obtained from the abdominal region and from other parts of the animal which do not constitute beef. At present the better fats, especially those which may readily be detached by cutting or pulling, are so largely destined for use as a constituent of butterine that these are known as butter fats. An average beef animal will produce from sixty to seventy-five pounds of such fat. By heating, oleo stock is first derived from these fats. This is nearly the same in constitution as ordinary prime tallow, and if the market for oleo products is much depressed, tallow may be produced for sale instead of oleo stock. Otherwise the stock is subjected to powerful pressure, which separates the oleo oil from the stearin, both of which are standard marketable products. Some of the packers, however, use part of their oleo oil and stearin in manufacturing butterine, lard compounds and cooking-oils.

" A moderate quantity of tallow and grease, of several grades, is secured, by cooking the heads, feet and other offal, but the quantity and value of fats of this character are much less than those of butter fats.

" The third by-product of a beef animal, in order of importance, is the tongue, which is either sold fresh, or more often is cured or canned. The leading packers ordinarily designate all parts of cattle, except the dressed beef, hides, butter-fat and tongues by the term ' offal.' Among the various articles constituting ' offal ' the liver, heart, sweetbreads and tails may be marketed without other treatment than trimming.

" The other forms of offal require a much more extensive preparation in order to become satisfactorily marketable. From the heads are cut the cheek meats and other small bits of meat, and sometimes the lips, these meats being usually sent to the sausage department. One or two of the packers use part of the horns and leg bones of the cattle slaughtered in the manufacture of various novelties, otherwise these materials are sold to outside concerns for that purpose. The remainder of the feet, however, with the trimmed heads and various other minor parts and trimmings, are subjected to processes of treatment by means of which tallow, glue, neat's-foot oil and other minor products are extracted. The residue after such treatment is used for fertiliser. The blood of cattle and various soft parts not containing other valuable material are also converted into fertilisers. The leading packers manufacture a great variety of commercial fertilisers, including those in which phosphates and other mineral substances are combined with the animal products.

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* " Report of the Commissioner of Corporations on the Beef Industry."

"The only remaining by-products of any importance are those derived from the intestines, which are carefully cleaned and converted into casings for sausages and other similar products. The weasand, or gullet, and the bladder are also cleaned and made into containers for various commodities: some weasands, for instance, being used for packing snuff." *

Possibilities of the Meat Industry. It is of interest to recite these developments of the meat industry as showing what the possibilities are, and it brings us to recognise the principle that, as it pays to aggregate the by-products resulting from the slaughter of many animals, it would be to the advantage of the meat industry throughout the United Kingdom so to organise their abattoirs and the accessory industries that all the by-products could be handled together in bulk, so that the cost of manufacture would be reduced to a minimum, and by that means the maximum profit would be obtained for the benefit of the whole trade and of the nation.

It may be questioned if the cost of handling cattle, for example, in one town in this country could be even approximately compared with handling them in another, owing to the fact that the business of slaughtering and control is so divided up that it is impossible to arrive at any general figure as to expense. Owing, however, to the organisation of some of the largest companies in the United States, and to the fact that their returns are kept with scrupulous accuracy and in detail, it has been possible to generalise and average out the costs, and they form interesting figures. Thus, in 1903, the cost of killing, dressing, shipping and selling cattle amounted to practically 8*s.* per head; this item including 2*s.* 6*d.* for killing and dressing, 2*s.* 4*d.* for refrigeration and shipping, and 3*s.* 2*d.* for administration and selling.

The object in mentioning these matters is to show how the control of every product in connection with private abattoirs has been reduced to absolute certainty, thus enabling shippers to gauge the markets with greater accuracy and also to offer their products against any kind of competition.

The Controllers of the Meat-supply. There are three people who are concerned in the control of the meat-supply: the farmer, the meat-purveyor and the consumer, and the relative positions of these three are what must always govern any rules for inspection which may be made.

The Farmer's Responsibility. The farmer is in the position that he is the producer of the raw material, which has ultimately to be used as food, and it would appear to be his business to produce only live-stock which are free from disease. It would be beyond our scope here to discuss diseases in any great variety, but as a concrete instance of what the farmer may be expected to do, we may refer to the breeding of cattle with tuberculosis.

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* *See also* chapter on By-products.

It is well known that stud animals bought by buyers in foreign countries have to undergo the tuberculin test before they can be shipped, and they are also generally required to remain in this country for thirty days after the test. We know that a great many animals react to the tuberculin, and as these animals come from pedigree stock, they are considered to be of such value that they are not forthwith slaughtered, but are spread all over the country, and in this way perpetuate the disease. This is an unhappy state of affairs, which can only be rectified by State supervision, and would involve, first of all, the free supply of tuberculin in a pure condition, by the State. It would also involve such supervision and inspection of all abattoirs and the slaughter of animals reacting to tuberculin without any exception. No doubt such stringent enactments would be a hardship to begin with, but, on the other hand, the result would justify the means, as in course of time, tuberculosis, in so far as cattle are concerned, would be stamped out.

The Position of the Meat-purveyor. The meat-purveyor occupies the position towards the farmer of being the purchaser of an animal which is supposed to be free from disease, in so far as tuberculosis is concerned, which is the one disease we have selected as an illustration. There is no ready test which would enable the meat-purveyor to diagnose the presence of the disease in an animal brought to market, and there is no system of veterinary inspection which could be applied to markets and which would give to the meat-purveyor this advantage. He does not wish to buy tuberculous cattle, and when he pays his money, it is with the intention of purchasing animals that are free from disease, but, on the other hand, as he is naturally involved with the farmer in the supplying of meat for human consumption, it may be argued that he takes a trade risk in purchasing an animal which has not been tested, and therefore if the carcase of such an animal should be ultimately confiscated the loss should fall upon him.

We find that this system of responsibility in such matters has arisen in many countries, and it has been solved by the institution of a scheme of insurance to which the farmers and meat-purveyors sometimes contribute equally, and in other cases the premiums are paid by the meat-purveyors alone.

It is quite obvious, however, that the question is one which is very debatable, and it is likely that the many discussions which have taken place recently in this country will lead to some such universal system in the near future.

The Consumer. The third party concerned in the meat-supply is the consumer. Consumers certainly do not want to purchase tuberculous or diseased meat, nor do they pretend that they have any knowledge of what is wholesome meat or what is otherwise, but they demand, and demand rightly, that a system of control will be so devised that the meat-purveyor will be prevented from tendering to them such meat as is dangerous to health.

Laws Governing the Meat-supply. In many countries there are stringent laws governing the meat-supply, and in the various countries of Europe the State steps in for the protection of the consumer, and, as a consequence, we find that in such a country as Germany, for example, the whole system is so regulated that perfect veterinary control is enforced, and the primary condition of such a state of affairs is that all cattle and animals intended for human food are exposed in public markets and are examined on the hoof by veterinary officers, and they are slaughtered only in public abattoirs where the same complete control exists.

The control of the meat-supply in Scotland is governed by the Public Health (Scotland) Act of 1897, where it is laid down that "Any medical officer or sanitary inspector, or any veterinary surgeon provided for the purpose by the local authority, may at all reasonable times enter any premises within the district of the local authority or search any cart or vehicle or any barrow, basket, sack, bag or parcel in order to inspect and examine any animal or part of an animal intended for the food of man."

It is provided that on such examination being unsatisfactory, the animal or part shall be condemned. If, however, it has been exposed for sale, the person in whose possession it is found shall be liable to a penalty not exceeding £50 for each particular article, or in the discretion of the sheriff, he is liable to imprisonment.

There is, however, a provision which seems to be just, namely, that if any carcase or part of it which has been condemned has been, within a recent time prior to its seizure, examined upon the premises where the animal was slaughtered and passed by a veterinary surgeon called in for the purpose, and he has granted a certificate of passing the carcase, then the owner shall be exempt from penalty or imprisonment.

Should a licensed slaughterhouse owner be convicted under such circumstances, he shall lose his licence.

The Public Health Act of England of 1875 is the authority in that country, and does not vary in any essential principle from the Scottish Act, excepting that it lays upon the owner of any condemned meat the onus of proving that it was not intended for the food of man.

Regulations Due to a Novel. More recent regulations, so far as Scotland is concerned, are contained in the Public Health (Regulations as to Food) Act, 1907, and which, as already stated, took effect on January 1, 1908, and empowers local authorities through their officers to examine meat as it arrives at our ports, and this seems a desirable regulation considering the facts to which we have already referred in connection with the huge increase which has taken place in our imports from abroad. These regulations had their origin in a romance dealing with the slaughteryards of Chicago * which appeared a few years ago, and gave rise to a world-wide propaganda against the methods of handling meat and meat-products in the United States. It is no part of our business here to inquire whether the book referred to contained accurate or exaggerated statements. Suffice it to say that we have now to deal with new regulations in connection with the import of foreign meats, which, to a certain extent, will ensure a control not hitherto exercised. Foreign meats will require to pass a kind of customs examination which will, apparently, be conducted by the medical officer of health—a provision which is altogether ridiculous. If the inspection is necessary, it should be conducted by veterinary meat inspectors, who are familiar with the business. The regulations were designed, first of all, to control the import of boneless meat and similar products; this being classed as "Foreign Meat, of Class I." There is, however, a second class which is concerned with the importation of the carcases of pigs from which the lymphatic glands about the throat and elsewhere are absent, thereby preventing the detection of tuberculosis and other diseases in the carcases. The third class consists of getting meats bearing an official certificate of the place of origin, and which shows that it has been passed at the time of slaughter.

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* "The Jungle," a novel by Upton Sinclair.

A Celebrated Sausage-shop alongside a Church at Nürnberg

Generally, the object of the regulations is to prevent the importation of foreign meat which would in any way be detrimental to the public health.

In the Interest of the Public Health. It will also be obvious that these regulations involve an extension of the powers vested in meat-inspectors, and recognition of the main principle that all meat intended for human food should be examined in the interest of the public health by a qualified officer, and although the principle is not by any means new, it also involves the thorough education of such officers in the meat industry. Beyond that, however, it involves also the education of the meat-purveyors who have the distributing of the meats, and upon whose probity and knowledge the public consumers so largely depend.

If, therefore, any justification were needed for the plea that meat-purveyors should be educated in the technicalities of their business, it would be found in the fact that these regulations have become possible. It will be necessary in the future for the meat-purveyor to know the technicalities of his business just as well as the veterinary officer, and provision will have to be made for such education as meat-purveyors demand. There is no college in the United Kingdom, or for that matter anywhere else, which has attempted to organise a course of instruction for meat-purveyors. A beginning has been made, however, at the College of Agriculture, Edinburgh, where a series of lectures on subjects in connection with the meat industry have been given and will be continued in the future. This course was organised by the present writer, and, as showing the popularity of the subject, it may be mentioned that the number of students who attended averaged about 150, and this is a demonstration of what would be likely to occur in all great cities, as it has been clearly shown that the modern meat-purveyor is not only willing, but anxious, to learn the technicalities of his business.

PLATE X

PORK PIES, VEAL, HAM AND EGG PIE, AND GALANTINES

1. Melton Pork Pie
2. Veal, Ham and Egg Pie
3. Melton Pork Pie, cut
4. Melton Pork Pie, cut
5. Veal and Ham Pie, in tin
6. Galantine
7. Galantine, showing filling

Pies, galantines, &c., are made by sausage manufacturers, although, strictly speaking, they are not sausages. Nos. 1, 2, and 3 show the celebrated Melton Mowbray pork pie. Nos. 2 (veal, ham and egg pie) and 5 (veal and ham pie) are also productions of the Midlands. Nos. 6 and 7 exhibit the galantine.

We are indebted for the specimens from which these coloured pictures have been drawn to the following:

To Messrs. Wilkinson, Leicester, for the Melton pork pie and veal, ham and egg pie.
To Messrs. Samsons, Ltd., of London, for the galantine.

1

2

3

4

5

6

7

2 6.JUIL. 1920

CHAPTER VII

SAUSAGES

UNLIKE the martial deeds of kings, the making of sausages has not attracted the attention of the historian. We know that the Romans prized the sausages of Lucania, which were made of a mixture of pork, bacon, and white pine-nuts chopped fine, and flavoured with pepper, bay-leaves, pot-herbs, cummin-seed and garum sauce. Bologna has long been celebrated for its Mortadelle sausage. We have heard of a King of Spain who was a devoted amateur sausage-maker, and of towns claiming to be the first places where sausages were made, but it is doubtful if the materials exist for a history of the evolution of the sausage.

It would be interesting to know why the Germans have become a nation of sausage-eaters, and how they invented such a bewildering

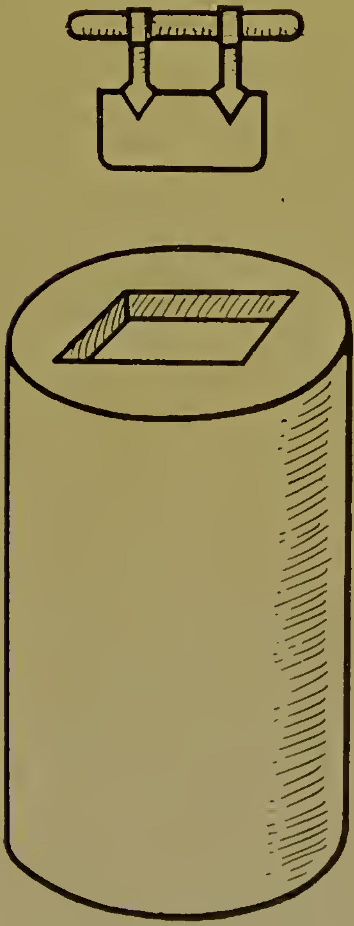


FIG. 1.—ENGLISH BLOCK AND HAND CHOPPER

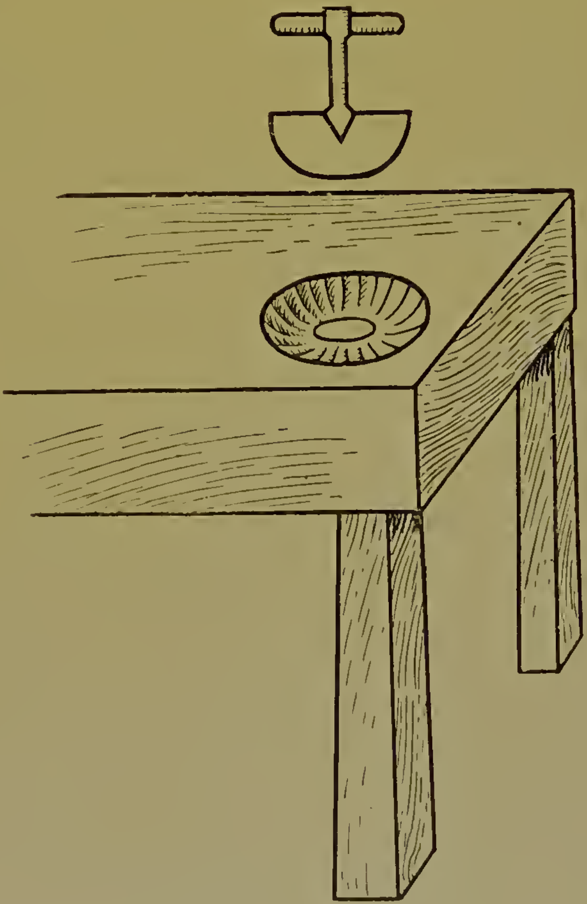


FIG. 2.—SCOTCH BLOCK AND HAND CHOPPER

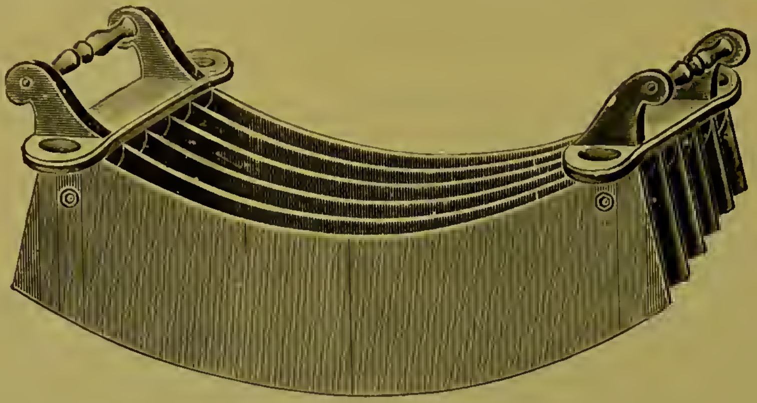


Fig. 3.—Rocker Cutter

variety of sausages, some of them, it must be confessed, rather fearful and wonderful to the taste of the average Englishman. Perhaps, in a country where everything is specialised, some learned German may arise who will produce a weighty treatise on the subject, but, so far as we know, he has not yet appeared.

How Sausages are Made. Sausages consist essentially of meat, usually pork or beef, with bread or other cereal material, chopped fine, seasoned with salt, pepper, spices, and herbs, and stuffed into the carefully cleaned intestines of pigs, sheep, or cattle. The manufacture was, until recent times, largely a domestic one ; it was very convenient when a pig was killed to turn some, at least, of the trimmings into sausages. The tools required were very simple ; a good board and an ordinary household chopper served for reducing the meat to the necessary state of fineness, and the mixed mass was stuffed into the cleaned intestines by hand. In old-fashioned farmhouses, especially in Scotland, one may still see quantities of these sausages, or " sasters," tied in circular form, and hung up in the kitchen to dry. They keep for a long time in this form, but grow hard and gradually alter in character with age, and the taste for them is an acquired one. The meat-purveyor who made his sausages for sale in the same primitive way had a slightly better outfit. Instead of a board

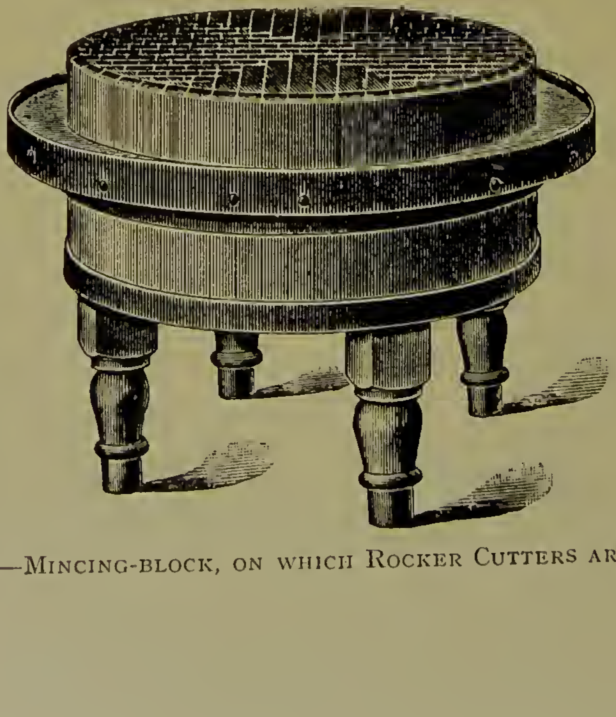
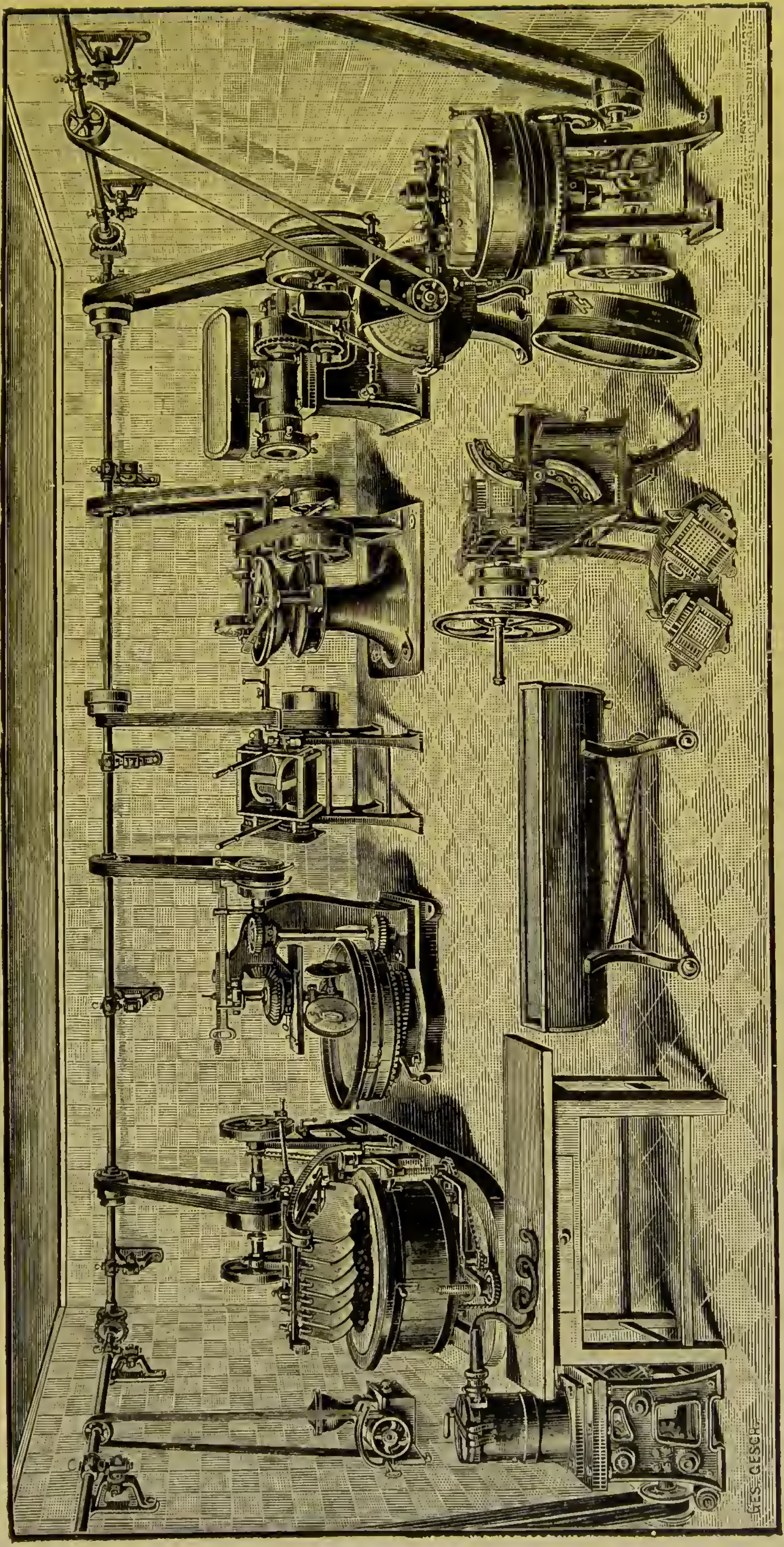


Fig. 4.—Mincing-block, on which Rocker Cutters are Used



General View of German Complete Outfit of Sausage-maker's Machinery he used a block consisting of the section of a tree, with a square hollow scooped out of the top surface, in which the meat to be chopped was placed. His chopper was like the domestic one, but larger, wider and heavier. The apparatus is illustrated in Fig. 1. In this case also the stuffing was done by hand. Scotch fleshers had a variation of the above apparatus, used both for sausage-making and cutting meat into "minced collops." The chopping-knife was half-round in shape, with a corresponding bottom scooped out of the thick ash table, which was both counter and cutting-up block.

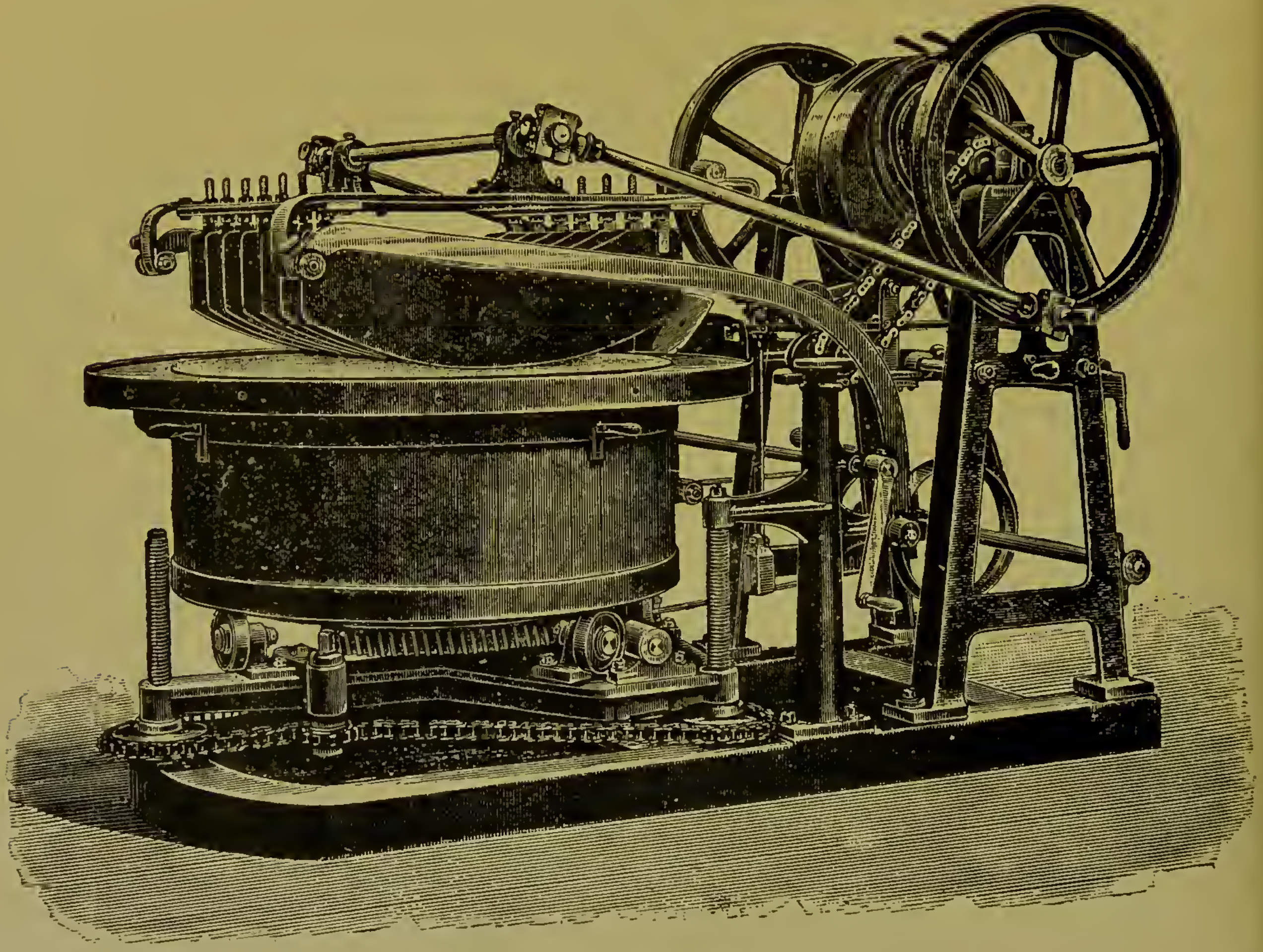


Fig. 5.—Power Rocker Cutter

In Germany, and among the German-Americans, an improved cutter called the "Rocker" (*see* Fig. 3) was, and still is, much used for hand-made sausages. It is a heavy tool composed of several semicircular knives fastened together with handles at each end, and is operated by two persons. The meat is placed on the surface of a wooden block, and the motion of the rocker, combined with its heavy weight, cuts it very efficiently, and there is the great advantage of several cuts being made simultaneously, according to the number of knives. Fig. 3 shows a six-knife rocker, and Fig. 4 a mincing-block.

It was not to be expected in this age of mechanism that people would remain content with these crude appliances, and indeed a very great

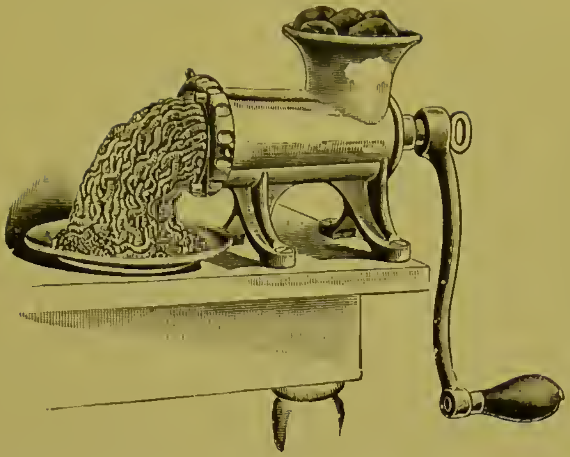


FIG. 6.—AMERICAN "ENTERPRISE" MEAT-CUTTER

amount of energy has been thrown into the invention of new types of sausage-making machinery, and so highly specialised has it become that one can buy a complete outfit at any price from a few shillings up to hundreds of pounds.

Within the limits of this book it would neither be possible nor profitable to describe all the varieties of sausage machinery in existence; all we can attempt is a description of the principal types. The first is the now old-fashioned vertical chopper, which is a development of the primitive block and hand-chopper, in which cranks, pulleys, gear-wheels and belts are used to increase its productive capacity. The block is mounted on a frame, and is made to revolve. The meat to be cut is placed on the top of the block, and the chopping-knives are made to rise and fall rapidly by cranks.

The power-rocker, also derived directly from the hand implements, is still very extensively used in Germany, but is scarcely known in this country. It is illustrated in Fig. 5.

A very popular idea with inventors has been the designing of meat-

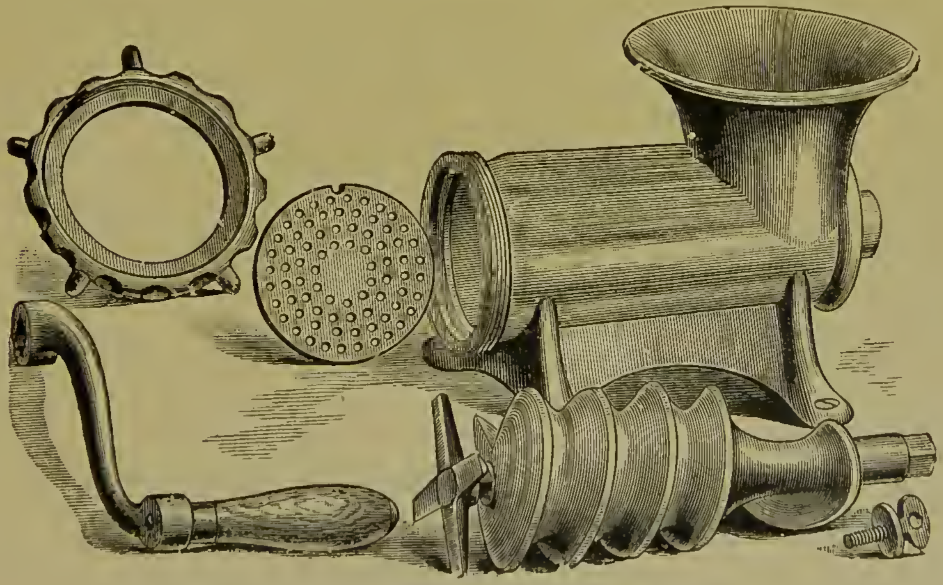
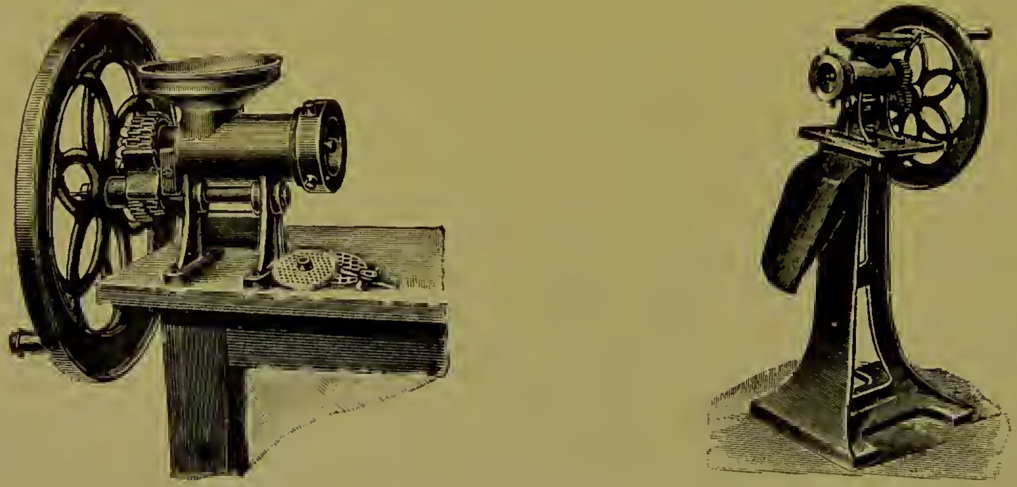


FIG. 7.—CONSTITUENT PARTS OF AN "ENTERPRISE" CUTTER

cutting machines with the following elements: a propeller, on the archimedean screw principle, driving the meat forward inside of an enclosing cylinder towards one or more knives, where it is cut to the desired fineness. The best-known machine of this type is the American "Enterprise" meat-cutter, the general appearance of which is illustrated in Fig. 6.

The constituent parts of the small "Enterprise" are exhibited in Fig. 7.

The body of the machine, which includes the cylinder, is fastened to the top of a table with screws, or with a screw-clamp in the smallest sizes. The propeller, or feed-screw, is placed inside the cylinder with one end of the spindle projecting through a small bearing at the hopper end of it. To this part of the spindle, the turning-crank, or handle, is fastened with a thumbscrew to keep it in position. The four-bladed cutting-knife is then placed on the other end of the feedscrew, followed by the perforated plate. The ring is screwed on to the cylinder, and the machine is ready for use. The meat to be reduced is fed into the hopper, where the propeller grips it and carries it forward to the perforated plate, on the inside of which the knife is revolving and cutting the meat to a fineness proportionate to the size of the holes in the plate. The inside of the cylinder is furnished with parallel projections which supply the necessary "kick" to assist the propeller in pushing forward the meat. We have described the action of this machine somewhat in detail, as it is one of the two great types of sausage-machines most in use at the present time. It is produced in many sizes.



Figs. 8 and 9.—Small-size "Alexander" Machines, for Hand-power

The Germans have further developed and specialised this machine. The "Enterprise" has a solid propeller with the spindle all in the piece, but the German "Alexander" machine has the propeller hollow with the spindle separate and revolving inside it, and driven at a different speed. In this way the knives revolve much faster than the propeller, and the crushing of the meat, which may result from the propeller bringing it along faster than the knife can deal with it, is obviated. In the German machines also, provision is made for using one, two, or three knives and

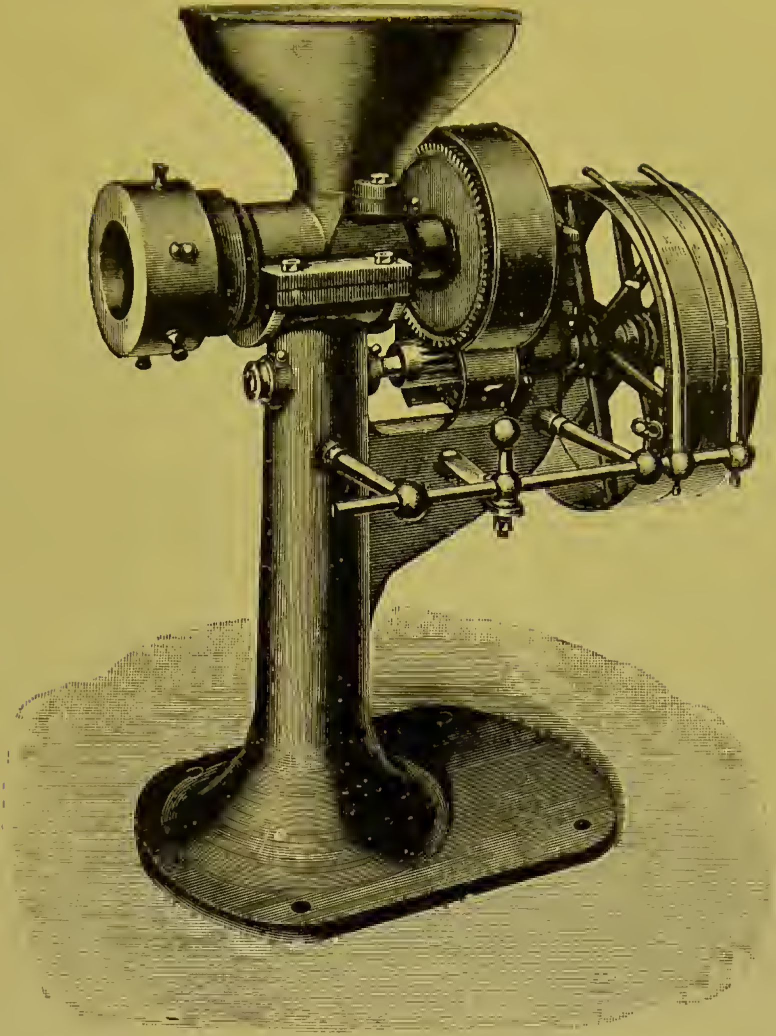


FIG. 10.—AN INTERMEDIATE ALEXANDER MACHINE, FOR POWER

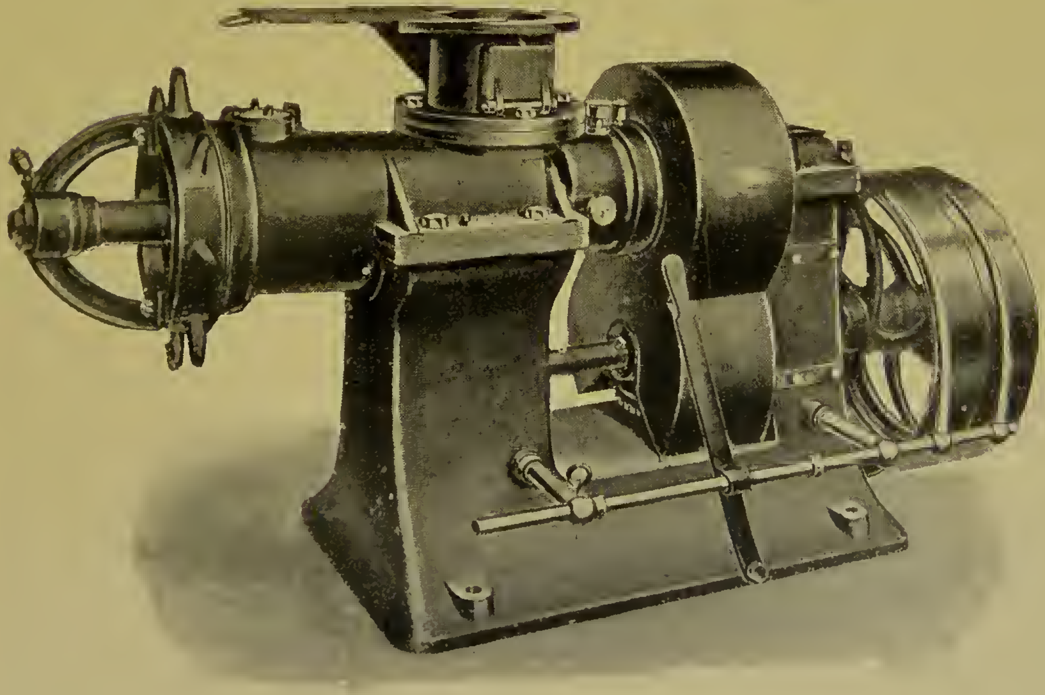


FIG. 11.—THE LARGEST SIZE ALEXANDER MEAT-CUTTER, FOR POWER

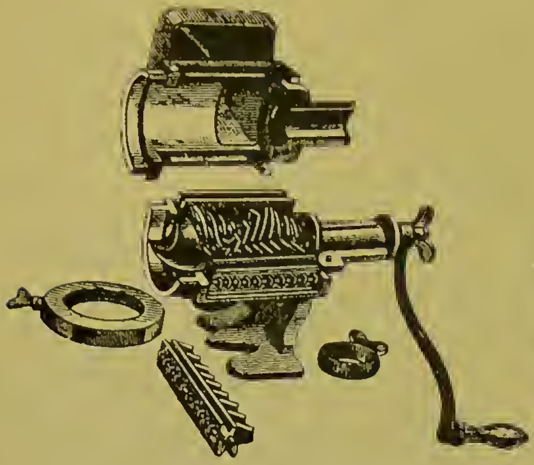


Fig. 12.—Propeller Machine

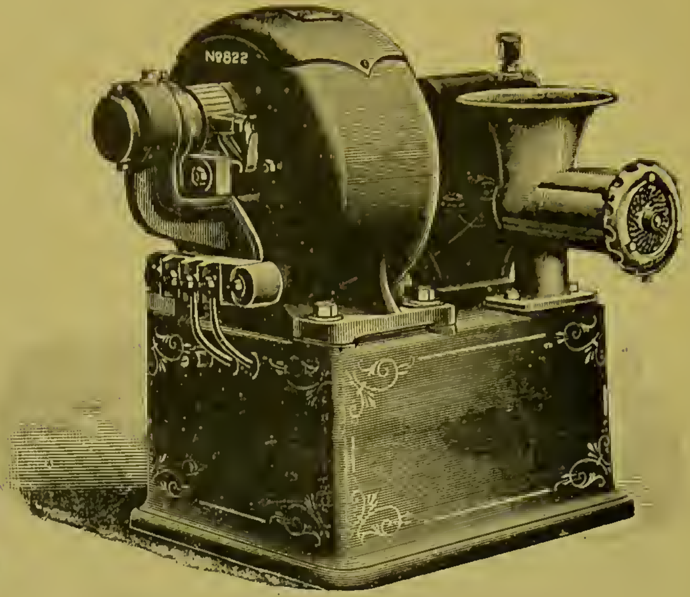


Fig. 13.—Enterprise Sausage-machine for Electric Motor Drive
(For $\frac{1}{2}$ or $\frac{3}{4}$ h.p. motor: direct current)

plates together, so that as many as five cuts can take place simultaneously. The perforations in the plates are much more varied, too, and permit of the production of fine paste, or quite rough pieces, either round or square, and all intermediate cuts in the same machine.

Figs. 8 and 9 show small-size "Alexander" machines for hand-

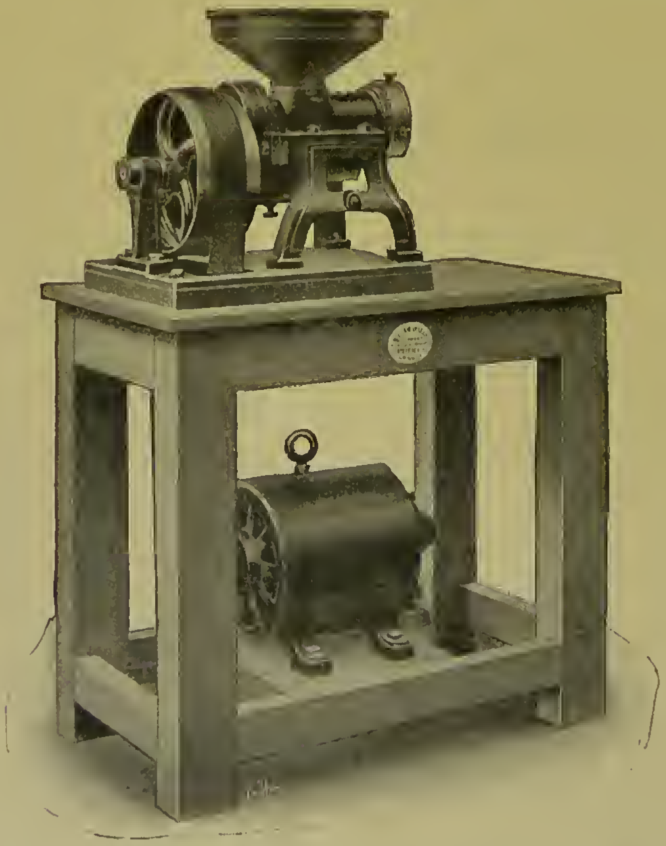


Fig. 14.—Alexander Sausage-machine mounted on a Table and driven by Electric Motor from Beneath

power, Fig. 10 an intermediate power size, and Fig. 11 the largest size made.

One advantage possessed by the "Alexander" type of sausage-machine is that of making a clean scissors-like cut. The process also is a continuous one, which is not the case with the other types of meat-cutting machinery. Both the fineness of the output and the size and capacity of the machines can be economically graded within very wide limits. The principal disadvantage is that the mixture of the ingredients: meat, cereals and spices, is not very thoroughly performed by the machine, and it is a general practice to associate with the larger machines, separate mixing-machines either for hand or power.

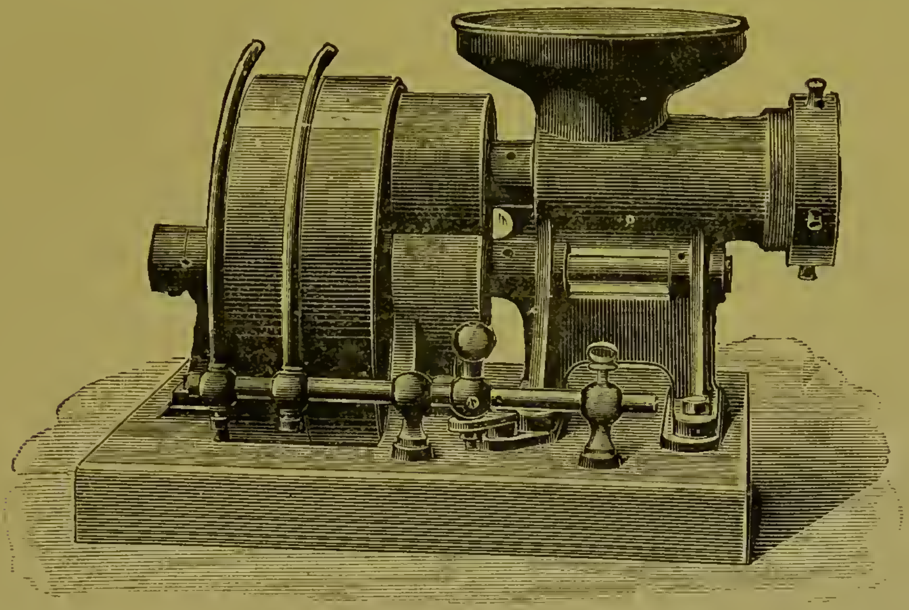


FIG. 15.—SMALL-SIZE POWER ALEXANDER SAUSAGE-MACHINE

There are many varieties of the propeller machine; one of the earliest still made by several English makers is shown in Fig. 12. The propeller consists of a number of segments specially arranged, and the knives which come between the segments are vertical and fixed to the bottom of the enclosing cylinder. In the larger machines a second set of knives is fixed. The meat is fed into the hopper in the usual manner, and as it is carried forward by the propeller it is cut by the knives which work in each segment. In some machines the perforated plate is replaced by one having radial grooves. The meat in being forced along these grooves is cut by a four- or six-bladed revolving-knife. Another modification is the use of two conical perforated plates, the one fixed and the other revolving, the latter acting as the cutting-knife. These machines are only made in small sizes.

The last machine we will notice is the silent meat-cutter, which, in the United Kingdom at least, is more used than any other, by people having a good trade in sausages. Originally a French invention, it has been greatly developed by English makers, and within the last few years has been making rapid headway in Germany.

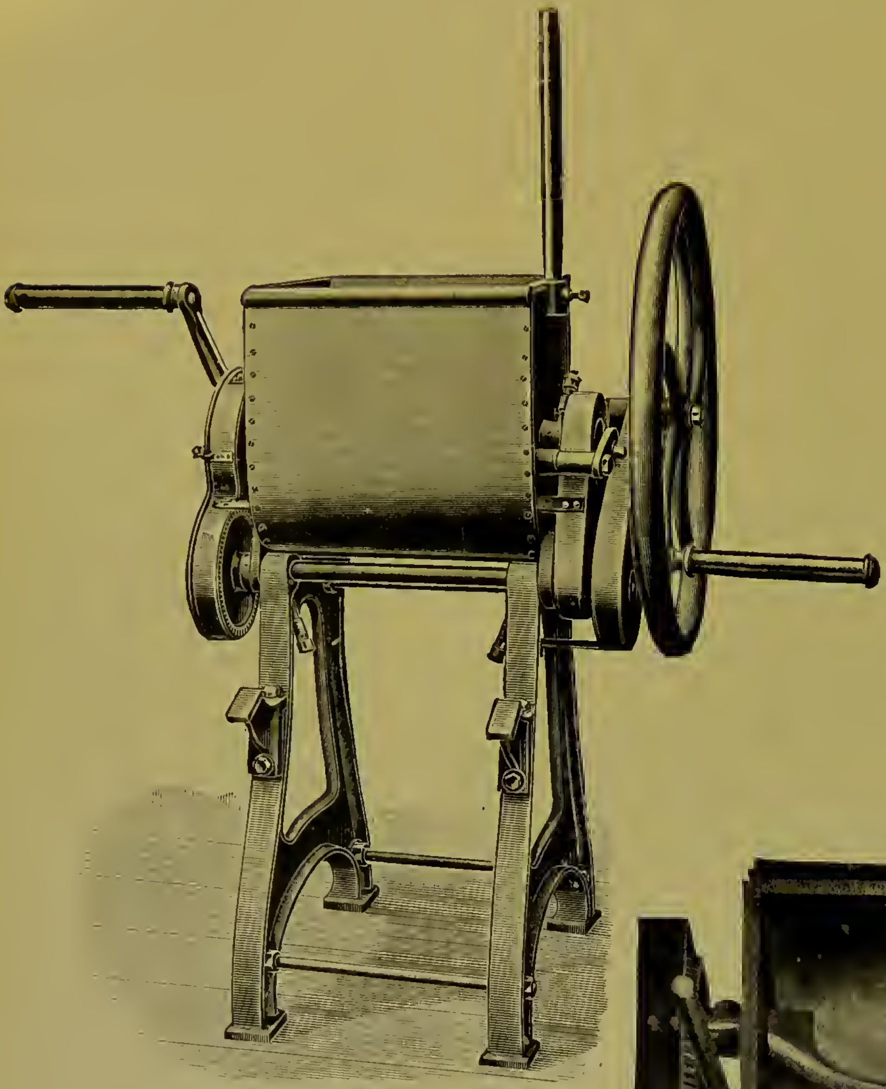


FIG. 16.—MIXING-MACHINE

A Typical Machine. On an appropriate frame, is mounted a cast-iron bowl, the interior surface of which is turned accurately to a section made up of the segments of two circles. The bowl is attached underneath to a vertical spindle, in which is fixed gearing for rotating it at a slow speed. Over the bowl is a horizontal spindle, at the one end of which are fixed four or five knives of a semicircular shape, the cutting edges of which almost touch the surface of one of the sections of the bowl as they revolve over it. On the other end of this horizontal spindle is the driving-gear. It is obvious that as the bowl revolves it carries the meat, &c., placed in it under the knives, which cut it up and at the same time mix it. The knives, as they leave the bowl, pass through a cleaner on the comb principle, which detaches the meat adhering to them. The machine is intermittent in action; the charge, which

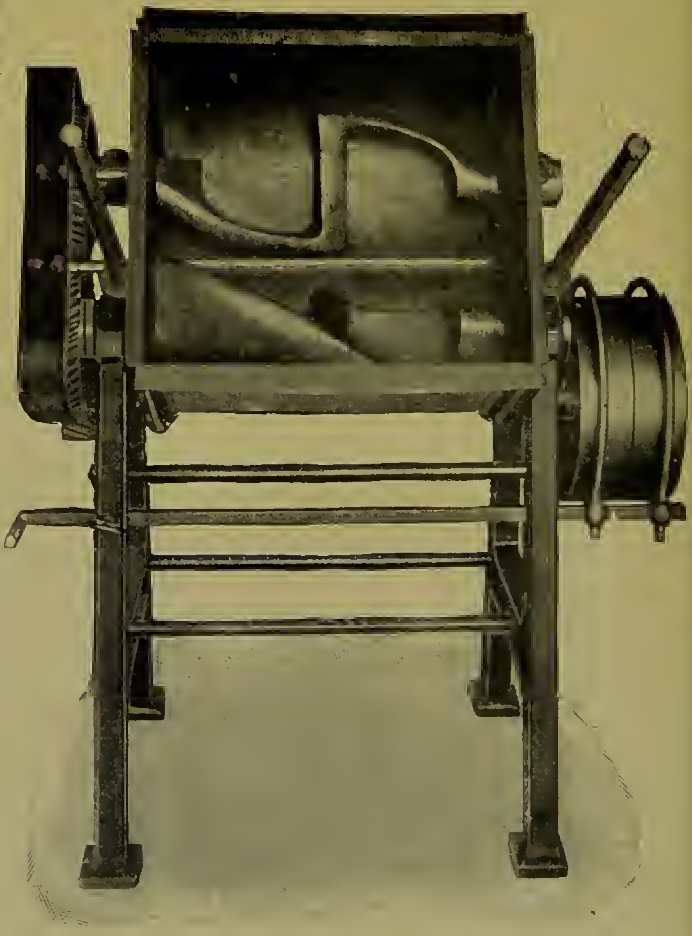


FIG. 17.—MEAT-MIXER FOR POWER, SHOWING INTERNAL GEAR

PLATE XI

SAUSAGES OF VARIOUS TYPES

1. Luncheon or German Sausage
2. Luncheon or German Sausage, cut to exhibit texture
3. Small Pork Weasand Sausages
4. Polony Sausage

5 and 6. Black Pudding, entire and cut
7. Polony Sausage, cut
8 and 9. Sheffield Polony
10 and 11. Ham, Chicken and Tongue
12 and 13. Garlic Sausage

The sausages here depicted are all of the long-keeping type. This is secured (1) by cooking, which sterilises the meat, and (2) by packing them in air-tight casings which form a practically impenetrable barrier to the entrance of putrefactive germs. They are frequently slightly coated with oil, which improves the appearance and assists in preserving them air-tight. Nos. 1 and 2 show the luncheon or large German sausage. It is in this instance coloured scarlet, but the general practice is to smoke this sausage, and it is therefore, as a rule, of a brown colour. No. 3 is a special weasand sausage of similar composition to the polony. Nos. 4 and 7 show the average polony. Nos. 8 and 9 a small polony made in Sheffield. Black puddings, Nos. 5 and 6. Ham, chicken and tongue, Nos. 10 and 11, and Nos. 12 and 13 a special garlic sausage.

We are indebted for the specimens from which the illustrations on this plate have been made to the following :

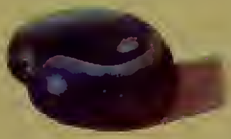
To Messrs. Annacker and Co., Ltd., Glasgow, for the luncheon or German sausage.
To Messrs. Samsons, Ltd., of London, for the small pork weasand sausage and for the garlic sausage.
To Messrs. Parr, of Nottingham, for the polony sausage.
To the Co-operative Bacon Factory, Roscrea, for the black pudding.
To Messrs. Gunston and Sons, Sheffield, for the Sheffield polony.
To Messrs. Wilkinson, Leicester, for the ham, chicken and tongue sausage.

1

2

3

4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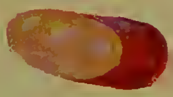
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13

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may vary from 5 to 120 lb. in the different sizes of machines made and to more than double this in some American machines, is placed in the bowl, cut and mixed, and then removed to make room for another exactly similar charge.

There are many different varieties of silent meat-cutters, but they may all be divided into two groups, viz., those where the power is conveyed to the knife-spindle indirectly from a driving-pulley placed low down on the machine and connected to the knife-spindle by a belt, and those in which the driving power acts directly on the knife-spindle.

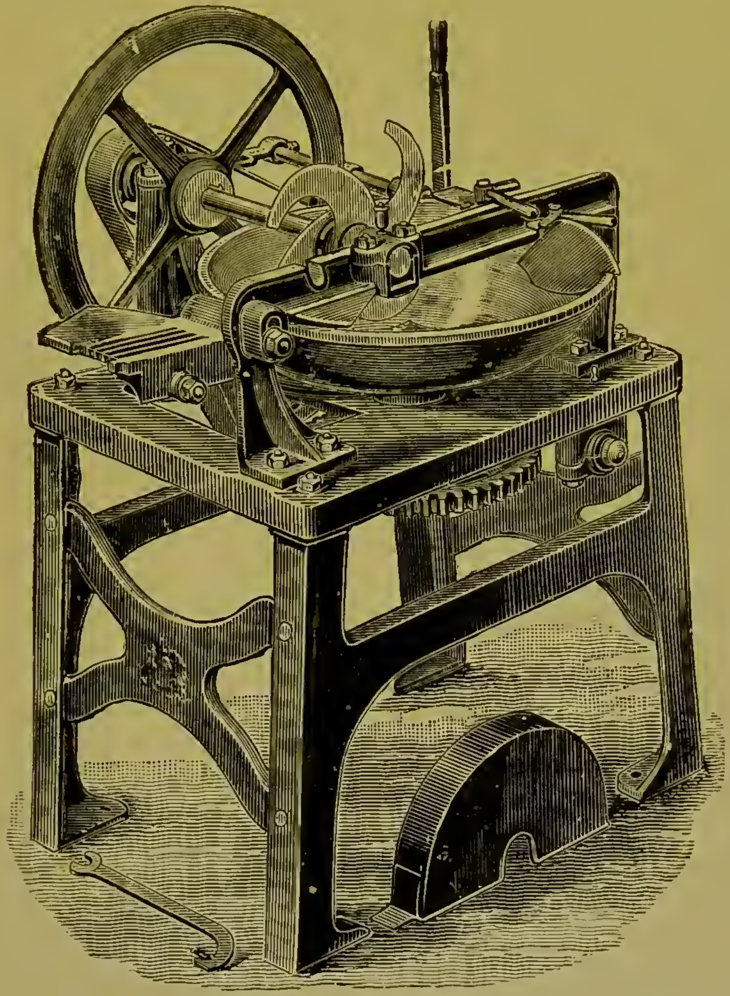


FIG. 18.—SILENT SAUSAGE-MACHINE, INDIRECT DRIVE

Fig. 18 is an example of the former. The direct-drive machine is the simpler, and the opinion that it is more efficient seems to be making headway. Fig. 19 shows a German design.

The above sufficiently illustrate the belt-driven silent machine, and on Fig. 20 is shown a hand machine of a design which is very popular.

After the meat, &c., is cut, the next operation is filling into the cleaned intestines, called in the trade "skins" or "sausage-casings."

The skins are bought in the salted state by the sausage-makers; cleaning, salting and packing them, being a business by itself. Besides those

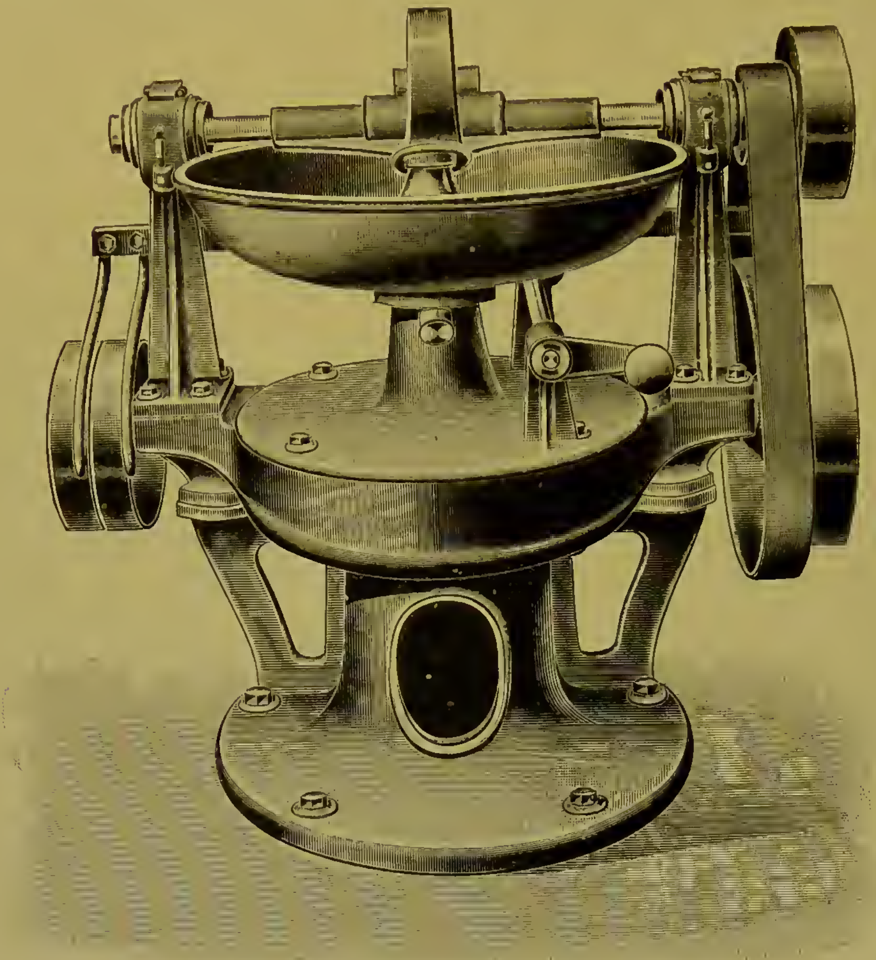


FIG. 19.—SILENT SAUSAGE-MACHINE

cleaned in the bacon factories and public abattoirs at home, very large quantities are imported from America. The principal casings used in this country are as follows :

Sheep-skins, consisting of the narrow intestines of the sheep ; the wider these are the better, and the heavy English breeds of sheep give wide casings which fetch high prices, and are exported on a considerable scale to America and other countries.

Hog-skins, the corresponding intestines of the hog, and the bulk of what is used here comes from America. The English and Irish bacon factories turn out a superior article which fetches a high price.

Middles and Runners are the narrow intestines of cattle, the former being the wider of the small intestines.

Bungs are the wide intestines of cattle.

Weasands are prepared from the inner skin of the throat or weasand of cattle.

The last two casings are not usually salted, but blown up and allowed to dry in the air, and are sold in this form or after deflation. Some other skins are used on a smaller scale, such as "sheep-bungs," "fat ends" (being the terminal part of the small intestine of the pig surrounded with fat), &c., and in Spain and other countries the intestines of the horse are used as sausage-casings.

The filling of the casings, like the cutting of the meat, has naturally become a mechanical operation, and many good filling machines have now taken the place entirely of the old hand-filling.

The Filling Process. The principle in all cases is the same: the chopped meat is placed in a cylinder open at the one end and at the other, closed with a rounded or "dished" cover, with the exception of an opening in the centre, to which is attached a nozzle of thin metal of about the same diameter as the sausage, the different varieties of casings requiring nozzles of corresponding diameters. A common type of hand-filler is shown in Fig. 21.

Skins are first soaked in lukewarm water to remove the salt and render them soft and pliable. The end is opened out and placed on the nozzle, and the rest of the casing pushed on to it by the finger and thumb. Quite a long skin can thus be placed on a short nozzle. Pressure is then applied to the sausage-meat by a "piston" or "block" fitting tightly into the open end of the cylinder, and forced forward by appropriate mechanism. The sausage-meat is thus squeezed through the nozzle, and as it emerges carries with it the skin which was placed outside of the nozzle, at such a rate that it covers the sausage-meat evenly, leaving neither slack nor tight places anywhere. Small meat-cutters of the propeller type have been ingeniously turned into sausage-fillers as well as meat-cutters, by the use of a nozzle with a funnel end.

After the meat has been cut, the knife and perforated plate are taken out and the funnel substituted, being held firmly in position by the ring. The chopped meat is fed into the hopper, and the propeller sends it forward through the nozzle, where it engages with the skin in the usual way.

The most widely used filler is the horizontal type, of which Fig. 22 is an illustration. The plunger is operated by a rack-and-pinion gearing,

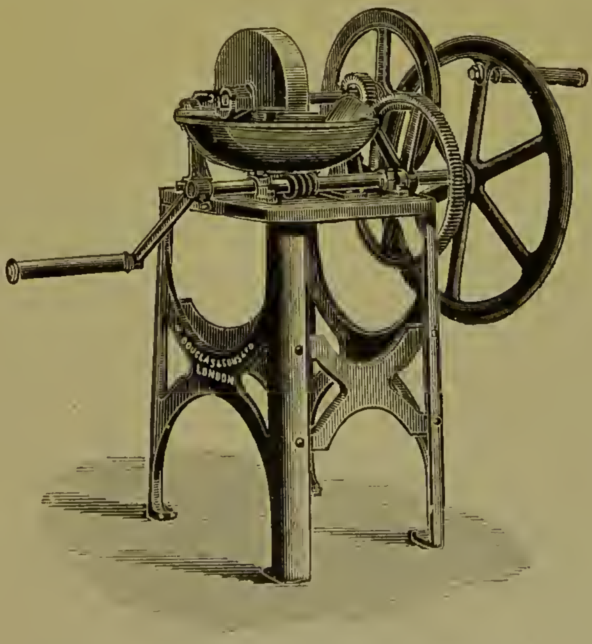


FIG. 20.—HAND SILENT MACHINE FOR SAUSAGE-MAKING

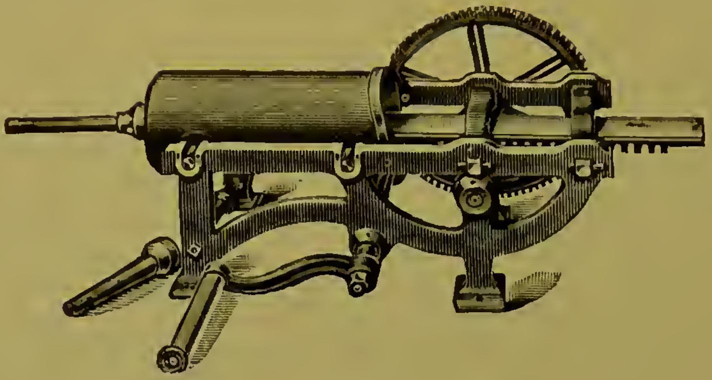


Fig. 21.—Small Hand Filler

and two speeds are usually provided, a slow speed for forcing the sausage-meat through the nozzle and a quick return of the piston-block when the cylinder is to be refilled. This is obtained by simply transferring the handle from one spindle to another. It is also usual to have a propping-up device for holding the cylinder at a convenient angle for throwing in the chopped meat when refilling. The meat should be forcibly thrown into the cylinder in convenient lumps so that it may be packed in solidly, with as few air-spaces as possible.

Fig. 23 represents a large horizontal power filler, driven by belting. In this case a pinion and screw arrangement is used instead of the rack-and-pinion gear for operating the block. The stopping and starting arrangement is a lever worked by a pedal, leaving both hands of the operator free for handling the sausages and skins.

Fig. 24 shows a vertical sausage-filler. The principle is exactly the same as in the horizontal filler, but the vertical filler is mounted on its own stand and can be moved about anywhere, while the horizontal filler must be screwed down to a table.

In America a direct steam filler has been invented—a steam cylinder and a filling cylinder both being placed on the same spindle. The apparatus has made no headway in this country, those who have tried it objecting to the heat given to the sausage-meat by the proximity of the steam. More success has attended the hydraulic filler, a design of which,

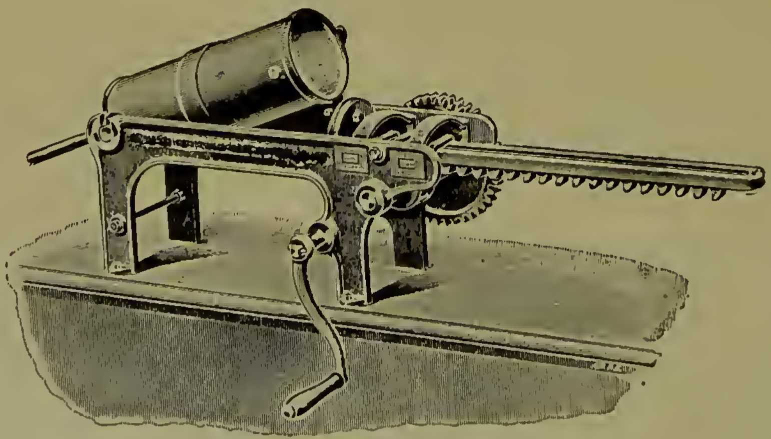


Fig. 22.—Small Hand-filler

as carried out in this country, is shown in Fig. 25. It consists of a belt-driven pump, connected to a hydraulic accumulator from which the power is taken to the filler. Where hydraulic power can be obtained from the street mains, the pumps and accumulator can be dispensed with.

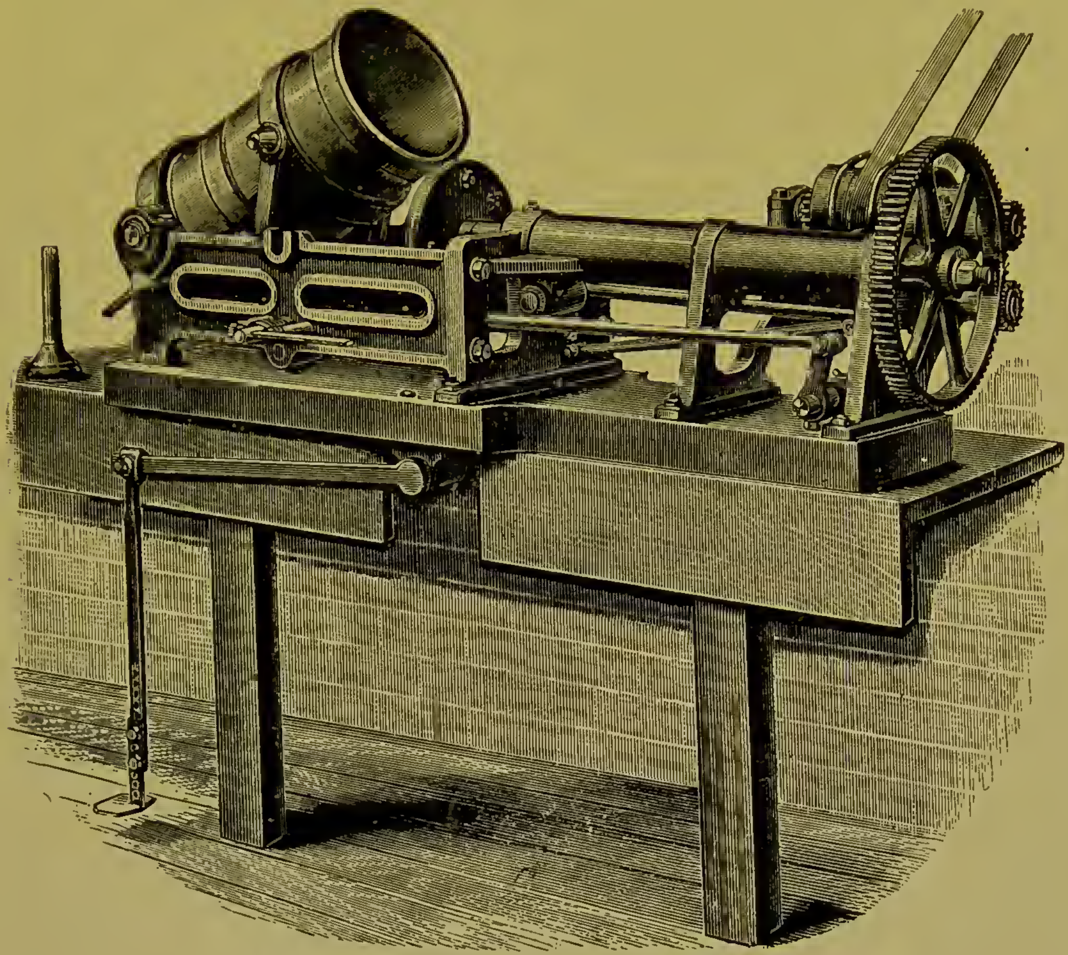


FIG. 23.—HORIZONTAL FILLER. FOR POWER.

In Fig. 26 an early type of horizontal filling-machine is depicted. It is crude, but interesting for comparison with more recent types.

The meat-cutter and the filler are the essential machines in sausage-making, but a good many others are used, especially by wholesale sausage-makers. The mixer has already been mentioned, but we have still the press for squeezing the excess of water out of the soaked bread which is added to the meat.

There are also fat-cutting machines (Fig. 27) for cutting long back fat into small cubes, which are mixed into certain varieties of sausages.

Cooking appliances, which may consist of (1) steam jacketed-pans; (2) gas-heated coppers; (3) portable boilers or (4) built in coppers. On the large scale steam-heated cooking appliances are now almost always used.

In addition, there is the smoke-oven or smoke-hole, which, until lately, was built of brickwork with an iron door, but now sheet-steel ovens are largely used, and have the advantages of being portable and of giving cool smoke which does not overheat the sausages.

The making of sausages was in quite recent times done entirely by hand, but the great development of the business has led to the introduction of power. The gas-engine, in sizes from one-half to two brake-horse-power, has been and is, extremely popular with pork- and beef-purveyors doing a moderate sausage trade, but it is gradually being superseded by the electric motor, which goes into the smallest space, can be started or stopped instantaneously, and requires very little in the way of lubricating oil and other stores. Where cooked sausages are handled the steam boiler and engine are still very much used, especially by country makers. An ordinary combination is a four-horse vertical boiler with a two-horse engine on one bed-plate, as in Fig. 28, and the boiler supplies a surplus of steam to heat the steam jacketed cooking-pans.

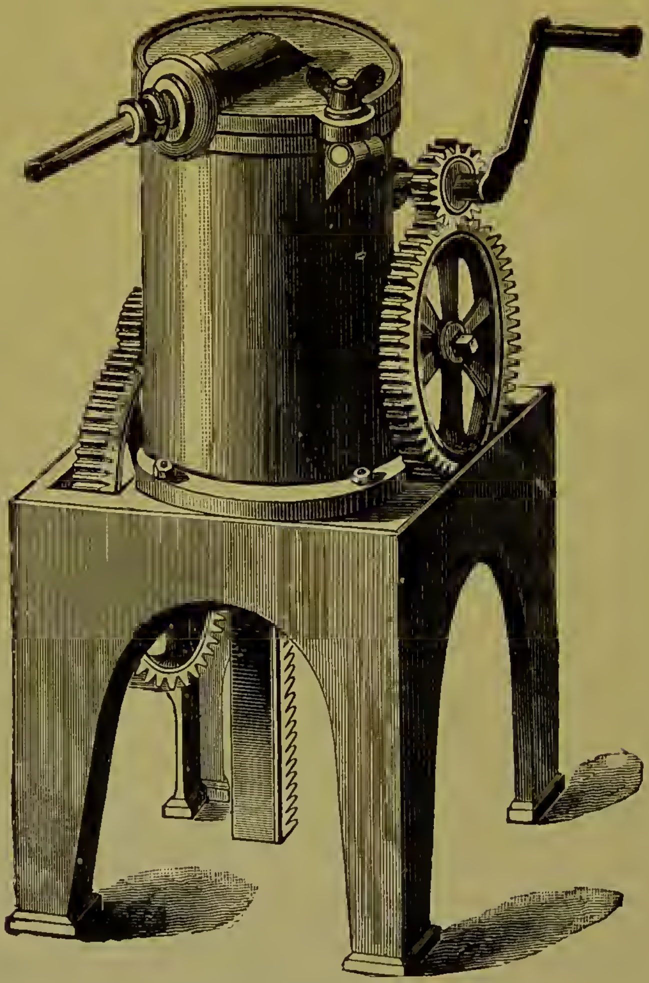


FIG. 24.—VERTICAL FILLER.

The engine may sometimes be combined directly with the meat-cutter, as in Fig. 29.

Practically all wholesale sausage-makers, and an increasing number of meat purveyors who make sausages, have refrigerating installations, and

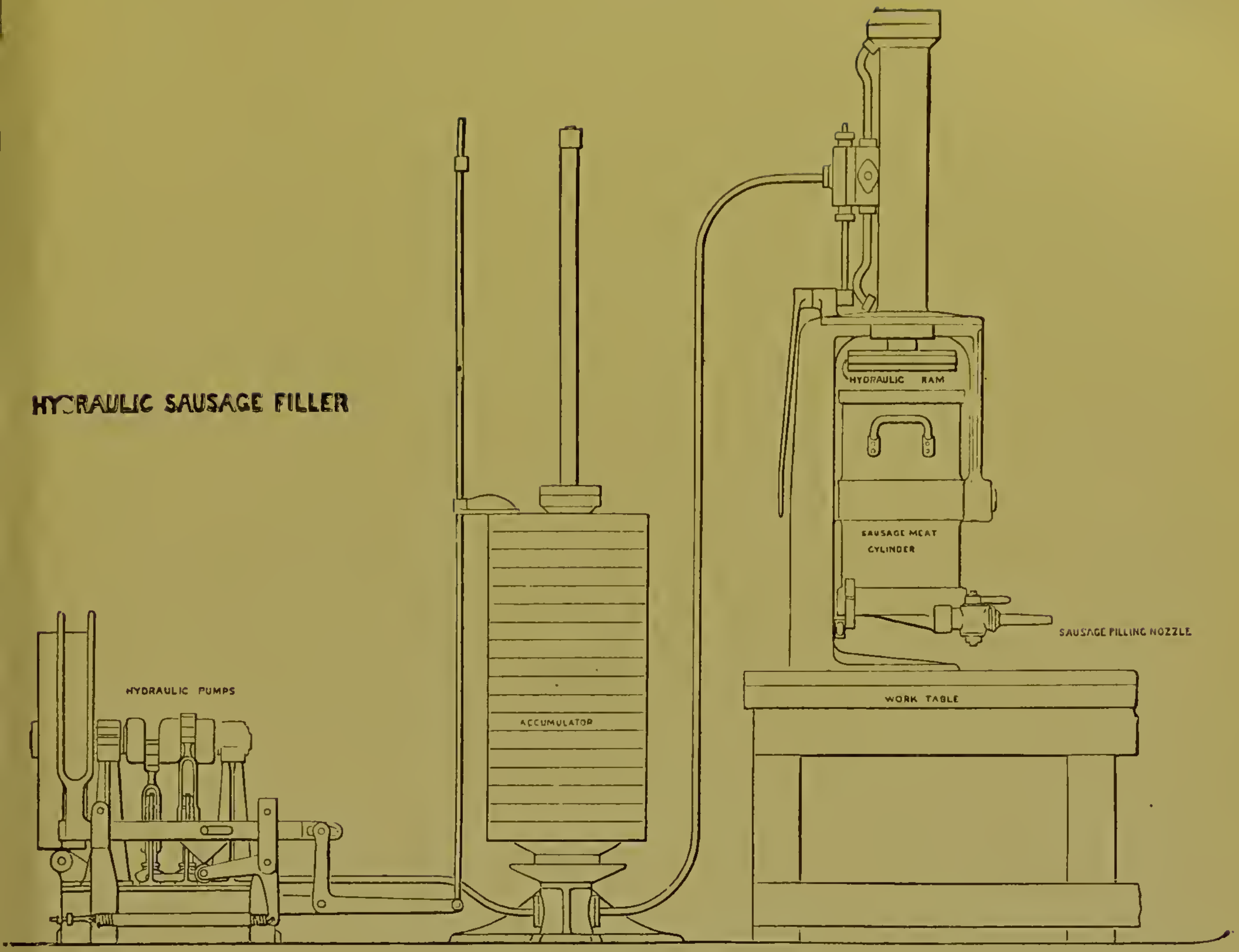


FIG. 25.—HYDRAULIC SAUSAGE-FILLER

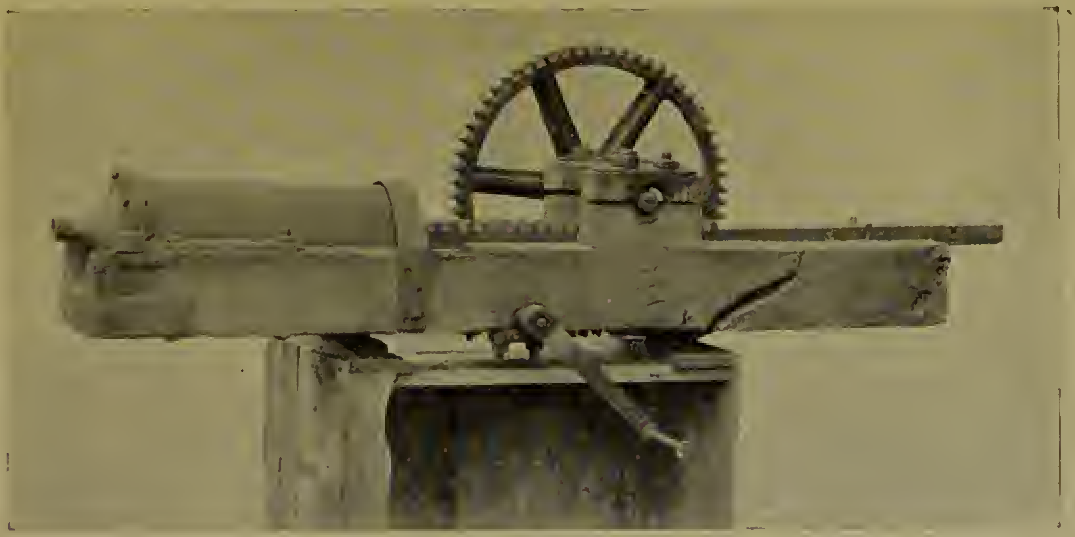


FIG. 26.—EARLY TYPE OF HORIZONTAL SAUSAGE-FILLING MACHINE

these are used for the preservation of the meat for sausage-making, and also for the sausages themselves. It is now well known that the propagation of the germs of bacteria which produce the decomposition is either entirely prevented or takes place very slowly at low temperatures, and if meat and sausages are kept at a temperature of 35–38° Fahr. they will remain fresh for a long time. The cutting-up and filling of the sausage-meat raises the temperature considerably, and it is advantageous to have the sausages quickly chilled as soon as they are made.

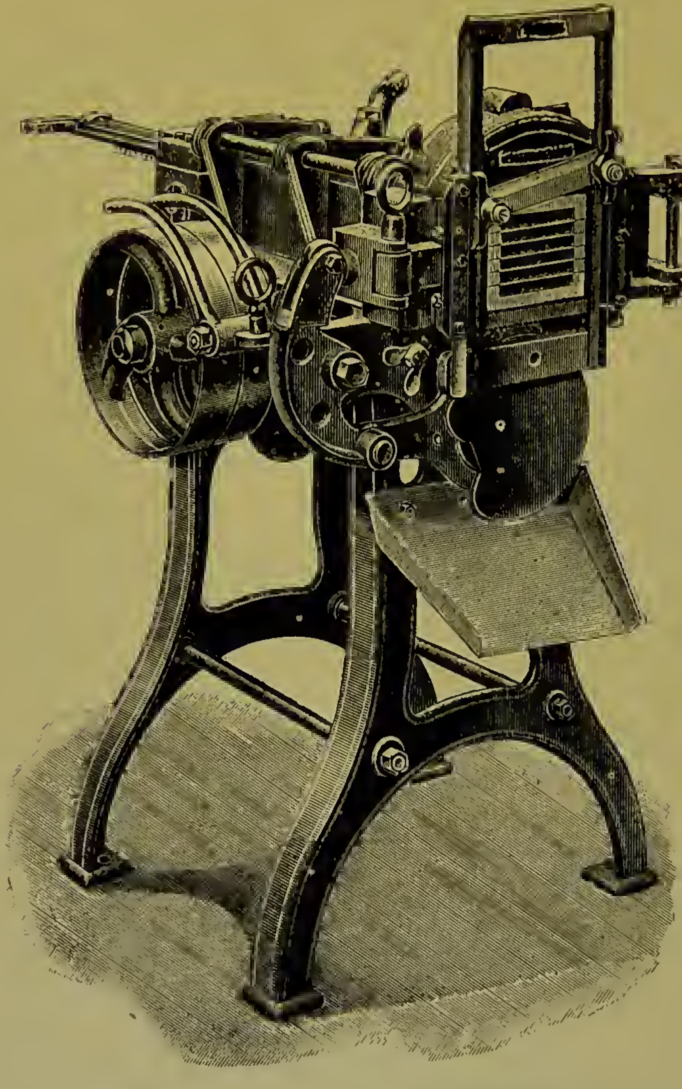


Fig. 27.—Fat-cutting Machine

An apparatus for this purpose consists of two small insulated rooms, each of which will accommodate a wheeled truck carrying five hundredweights of sausages. When the insulated door is closed a current of cold air is blown around the sausages, and the temperature is very quickly reduced to a safe limit. Newly killed meat is practically sterile, and it is common in Germany to take advantage of this fact by cutting

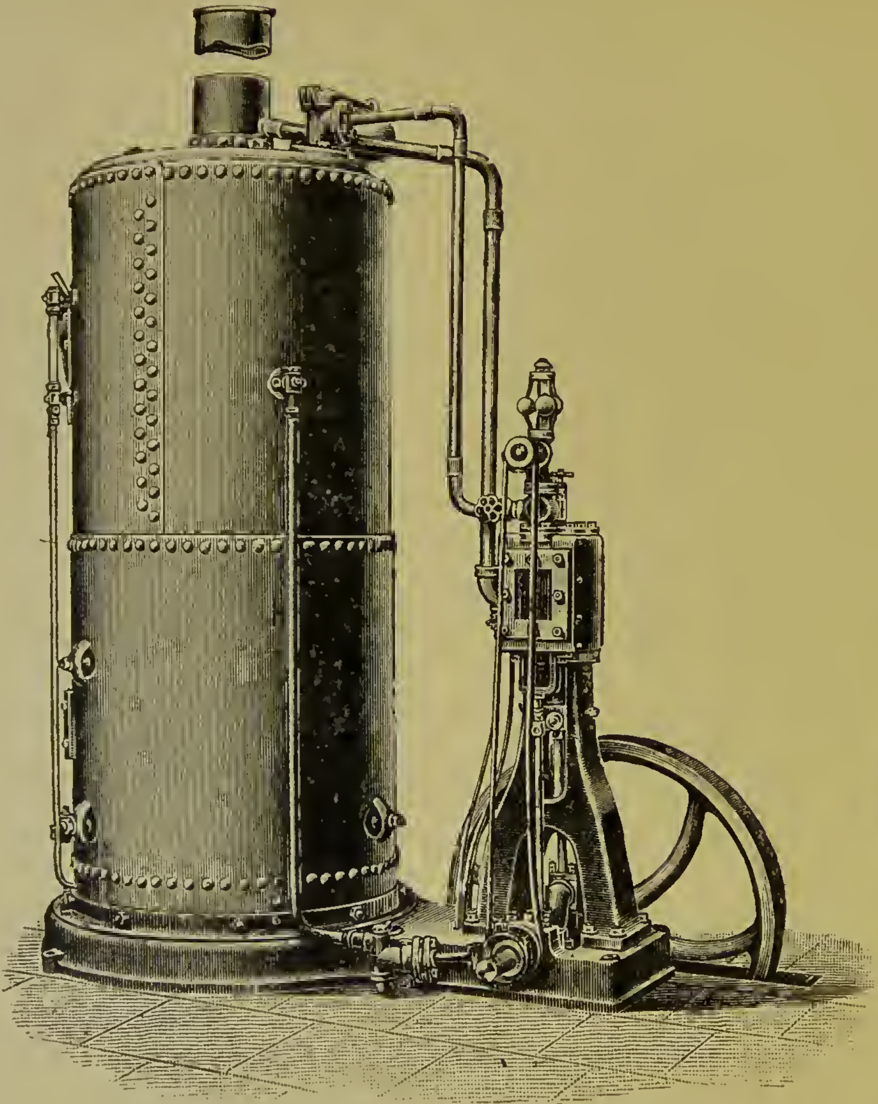


Fig. 28.—Vertical Boiler and Engine Combined

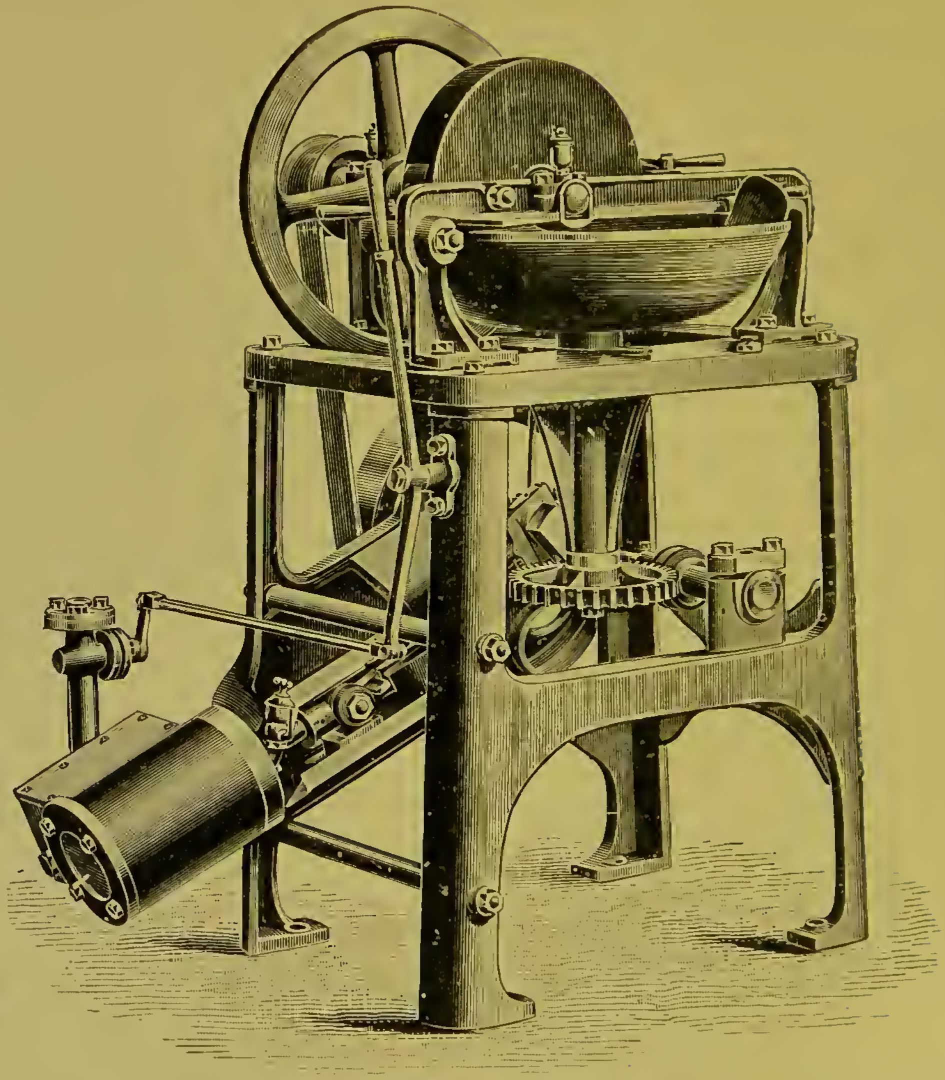


Fig. 29.—Silent Machine, Steam-driven, with Independent Steam engine attached

up the sausage-meat while still warm, and getting it inside the skins before it is much contaminated with bacteria germs from the atmosphere, &c.

The miscellaneous outfit of a sausage factory consists of tables, commonly with wooden tops, but preferably of slate, marble or enamelled iron; various receptacles for holding meat-bones, &c., all of enamelled ware if possible. One of the most useful appliances is an enamelled mounted trough on wheels for carrying sausage-meat from the cutter to the filler. Where bread is used, a bread-press is also necessary.

Good scales and weights are necessary, and a thermometer to test the temperature of the water for cooking is very useful. The best cooking temperature is 180° Fahr. If the water boils, it is very apt to break and disintegrate the goods.

Sausage-making machinery outfits vary enormously in cost, chiefly, of course, in proportion to the scale of the manufacture, but also in accordance with other conditions, such as the nature of the machinery and whether it is for hand or power, the buildings—the design of which may alter the cost of the means of power transmission, &c. No two plants, as a rule, are exactly alike, and it is impossible to make out sets of costs that will apply in all circumstances. We can only present approximate specifications of fairly representative plants, and this has been done in the following statements in the light of many years' practical experience of estimating for this class of work. We have seen that the range of capacity of sausage-making machinery is very wide; thus, a meat-cutter with filling attachment can be bought for five or six shillings, that will do good work for many years, but of course that would not be of any use to a practical tradesman. The smallest trade outfit is that described in No. 1, and it is used very extensively by small meat-purveyors in England and fleshers in Scotland—the great majority of Scotch fleshers are sausage-makers.

No. 1	£	s.	d.
No. 32 Enterprise or T. 32 Alexander meat-cutter		15	0
Gearing for ditto	1	12	6
One 10-lb. filling-machine	1	17	6
Total	£4	5	0

The above is hand-driven, but it may be converted into a power-plant, with electric motor, belt, special gearing, and including wiring, switchboard, &c., for an additional sum of about £20. The general-shop tools, tables, &c., would be sufficient as a rule.

No. 2

Hand-driven plant for a meat-purveyor doing a good sausage business, or a small pork-purveyor:

	£	s.	d.
Silent meat-cutter, of 15-lb. capacity	16	0	0
One 14-lb. filling-machine	2	5	0
Total	£18	5	0

An extra expenditure of about £25 would turn this outfit into a power-plant with electric motor, &c., as in No. 1, and in this case also the shop tools and tables would, as a rule, be sufficient.

No. 3

Power-plant for first-class pork-purveyor's business :

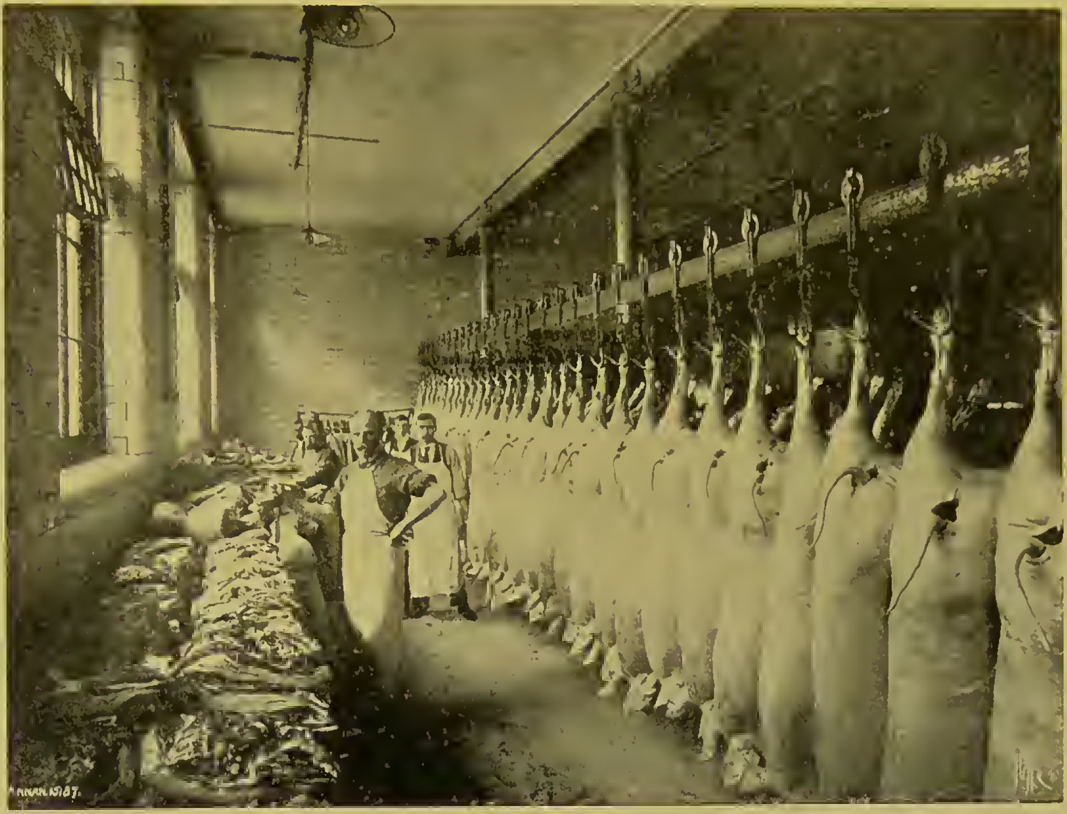
	£	s.	d.
One 22-lb. silent meat-cutter	20	0	0
One 45-lb. vertical sausage-filler	10	10	0
One 15-in. bread and lard press	3	10	0
One 6 ft. × 2 ft. 6 in. vertical boiler, combined with $4\frac{3}{4} \times 7$ vertical engine and feed-pump, on one bed-plate	65	0	0
Two 50-gallon steam jacketed cooking- and rendering-pans	29	14	0
Steam and water connections, say	12	0	0
Shafting, belting and pulleys, say	8	0	0
Tables, say	6	0	0
Steelyard, scales and weights	3	10	0
Tools	1	0	0
Portable smoke-oven	9	0	0
Delivery and fitting up machinery, say . . .	12	0	0
Total	£180	4	0

No. 4

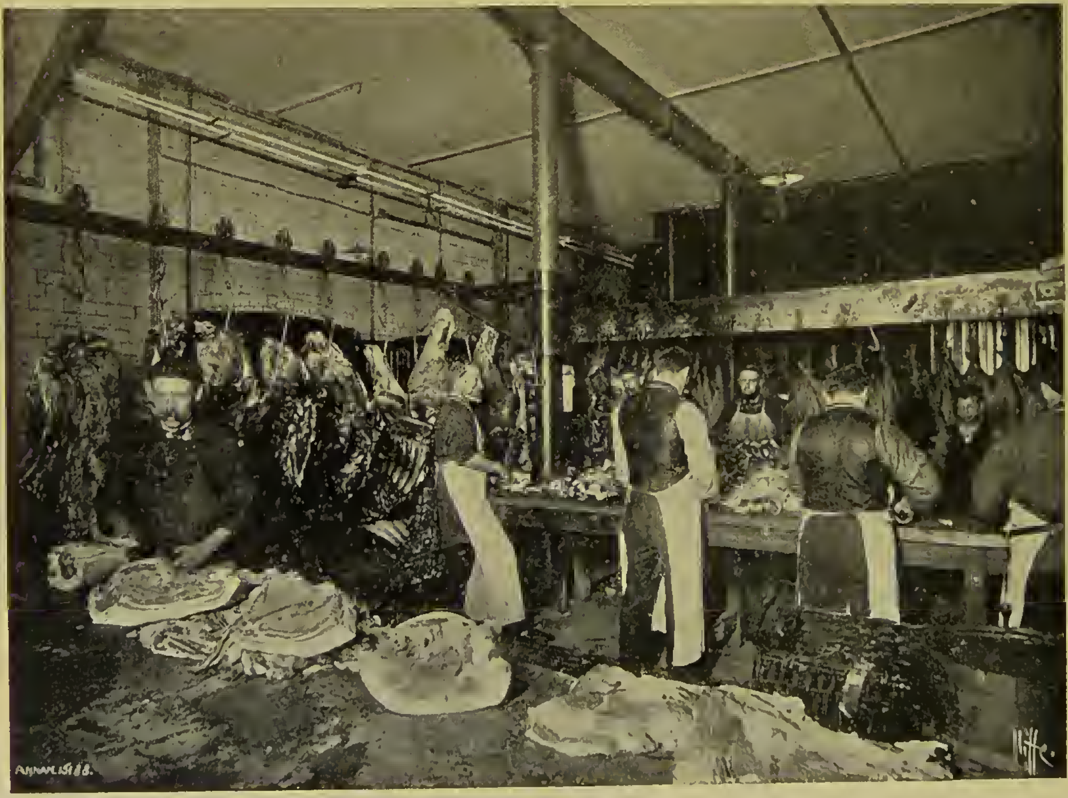
Power-plant, for first-class meat-purveyor's business :

	£	s.	d.
One 22-lb. silent meat-cutter	20	0	0
One 45-lb. vertical filler	10	10	0
One 15-in. bread-press	3	10	0
One gas-engine	34	0	0
Belt, say	1	0	0
Delivery and fitting up, including connections, say	10	0	0
Steelyard, scales and weights	3	10	0
Tables	6	0	0
Tools	1	0	0
Total	£89	10	0

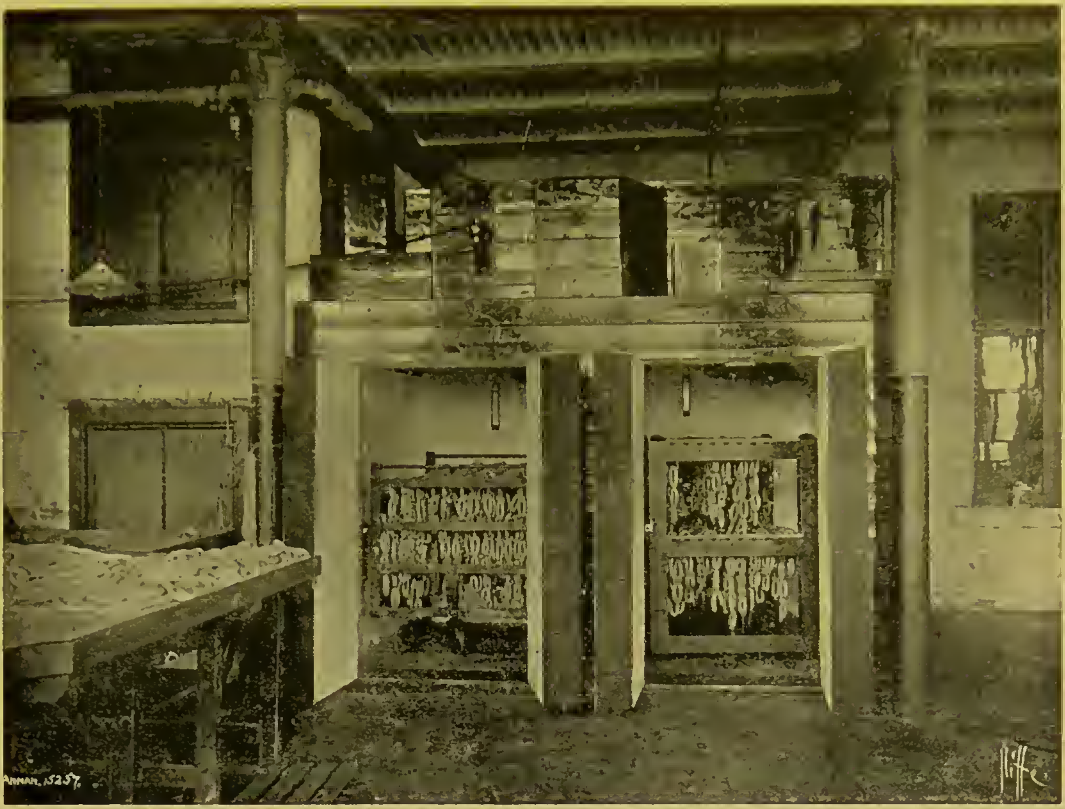
An electric motor might be substituted for the gas-engine without materially altering the total cost.



Hanging and Cutting-up Room in Sausage Factory



Boning and Preparing-room in Sausage Factory



Apparatus for Chilling Sausages

Sausage-filling Room

No. 5

Plant for a first-class sausage factory:

	£	s.	d.
Two 40-lb. silent meat-cutters	80	0	0
One cutter, of propeller, knife and plate pattern .	25	0	0
One power meat-mixer, of 110-lb. capacity . .	22	10	0
One power vertical sausage-filling machine of 80-lb. capacity	37	10	0
One hand ditto, of 45 lb. capacity . . .	10	10	0
One power meat-paste brushing-machine . .	15	0	0
One power brawn meat-cutter	25	0	0
Two 18-in. bread and lard presses . . .	9	0	0
Six 70-gallon steam jacketed cooking- and rendering-pans	102	0	0
One 6 ft. × 3 ft. × 18 in. canning-vat . . .	20	0	0
One 5-cwt. bone digestor, with stand, cage, overhead hoisting and travelling gear, &c. . . .	57	10	0
One portable smoke-oven, 8 ft. × 4 ft. × 4 ft. .	14	0	0
Four 300-lb. portable enamelled cart and van meat-troughs	13	0	0
Refrigerating machinery	285	0	0
Insulated cold-rooms and sausage-cooling rooms, say	130	0	0
Shafting, belting and pulleys, say . . .	56	0	0
Two 5-cwt. sausage waggons	12	0	0
One 11 ft. × 4 ft. 6 in. vertical steam boiler, combined with 11½ in. × 16 in. vertical steam-engine, with feed-pump	230	0	0
Water-pump and connections	41	0	0
Steam connections, valves, traps, &c., say . .	30	0	0
Delivery and fitting up, say	100	0	0
Tables	12	0	0
Tools and sundries, say	25	0	0
Total	£1352	0	0

In the following interior views of sausage factories the first series of illustrations have been drawn from representative British establishments, where the by-products are fully utilised and even the bones are steamed and ground into bone-meal before being parted with. The second series, which appears at the end of this chapter, is from a corresponding German factory.

It has already been stated that the principal meats used in sausage-making are beef and pork, but veal is also an essential ingredient of some sausages, and ham, chicken and tongue should be essential ingredients of others, but we fear that generally the chicken is left out. Then there are black and white puddings, the former being sausages made chiefly of blood, and the latter of fat and cereals. To make good sausages the first consideration is that the appropriate quality of meat must be selected. No amount of spicing will turn poor meat into first-class sausages. Even to make cheap sausages some selection is required, and altogether the would-be sausage-maker needs much experience, of a sort that can only be acquired in shops and markets.

Of the other ingredients used in sausages, bread is the principal; it must be good and fresh, and free from charred crust which would injure the appearance of the sausages. The bread is steeped in water until soft; the surplus water is squeezed out in the screw and cullender press already referred to. Rice in the granulated and fine forms is much used instead of bread; it is scalded with about three times its weight of boiling water, and on cooling is of the right consistency for working into the sausage mixture. Farina, or potato flour, is greatly used for some varieties of sausages, and corn-flour is also sometimes put into requisition. Black puddings commonly contain whole barley or groats, and also frequently fresh onions. Scotch white puddings are made up largely of oatmeal.

Of late years several special preparations have come into the market, such as bread meal, ground from bread that has been dried hard in an oven; biscuit-powder, from biscuits containing no sugar; steamed and rolled rice, &c.

The Question of Colouring-materials. The almost universal use of colouring-materials in sausages has led to a good deal of discussion. No one would defend the use of harmful colourings in any kind of food. The question of harmless colourings in sausages is only a branch of the larger question of the use of colouring in food-stuffs generally, in which the confectioner, the baker, the dairyman, and many others, including even the distiller and brewer, are interested. It cannot be discussed here. We can only recognise that nearly every one uses colourings, and give some account of such of these as are harmless.

The colouring-matter which at one time was most extensively used is "Armenian Bole," a natural red oxide of iron with some clay sandy matter, &c., as impurities. It is better that the oxide of iron prepared artificially should be employed, because it is practically free from the above impurities, and being of high tinctorial power, a little quantity suffices. While these iron colours are still very much used, they are gradually being replaced by "aniline" dyes, which give brighter shades. Some aniline dyes are injurious, but the quantity used is so extremely small that probably no harm would be done even if they were poisons. At the same time there is no need to use any but harmless dyes, and it is a pity that the authorities in this country do not issue a list of dyes which may be used as food colourings, and those which may not so be used. This has been done in Germany to the advantage of all concerned.*

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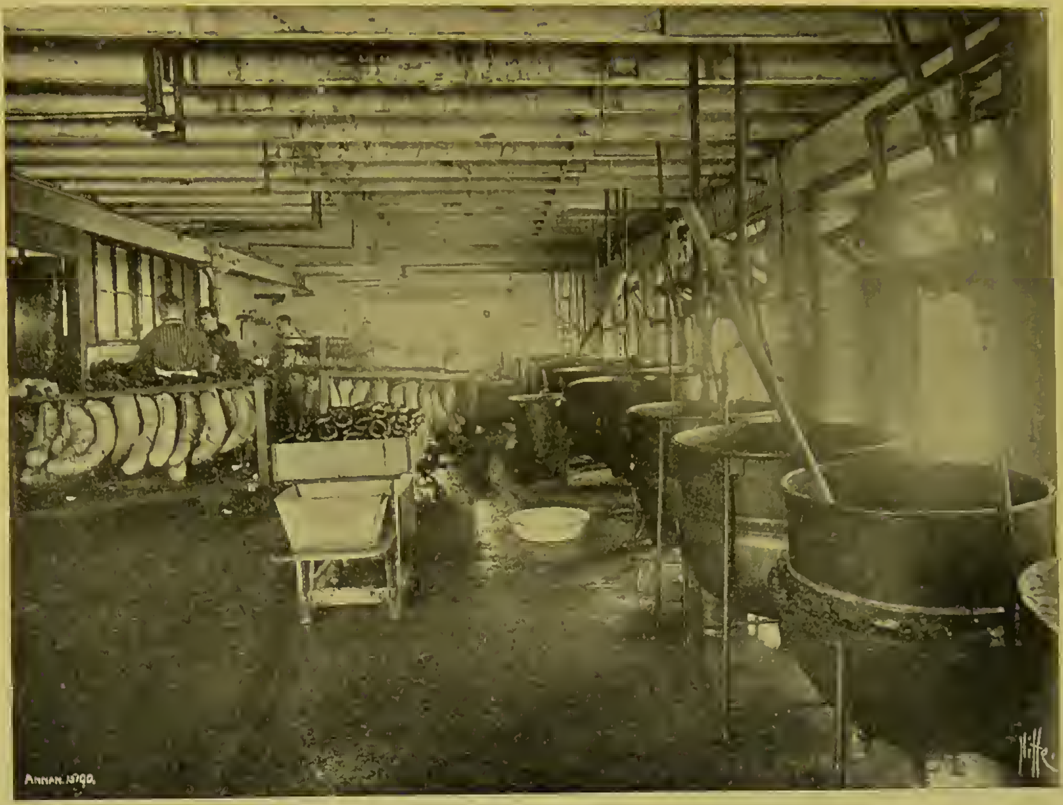
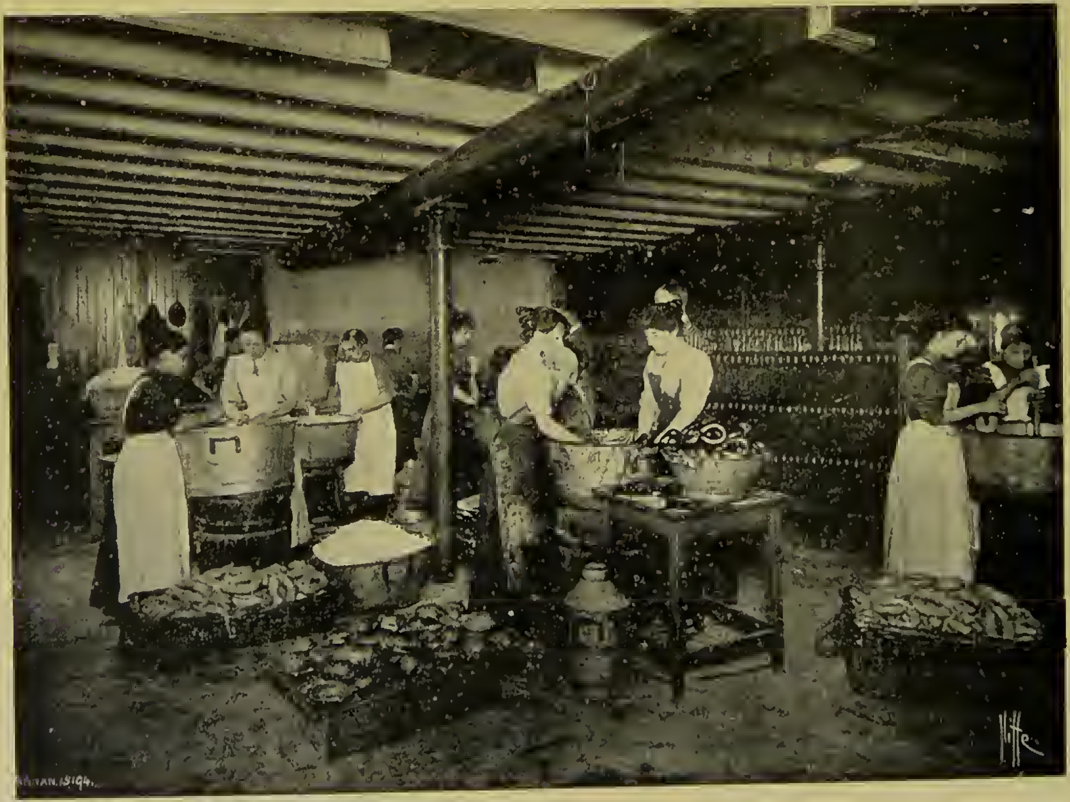
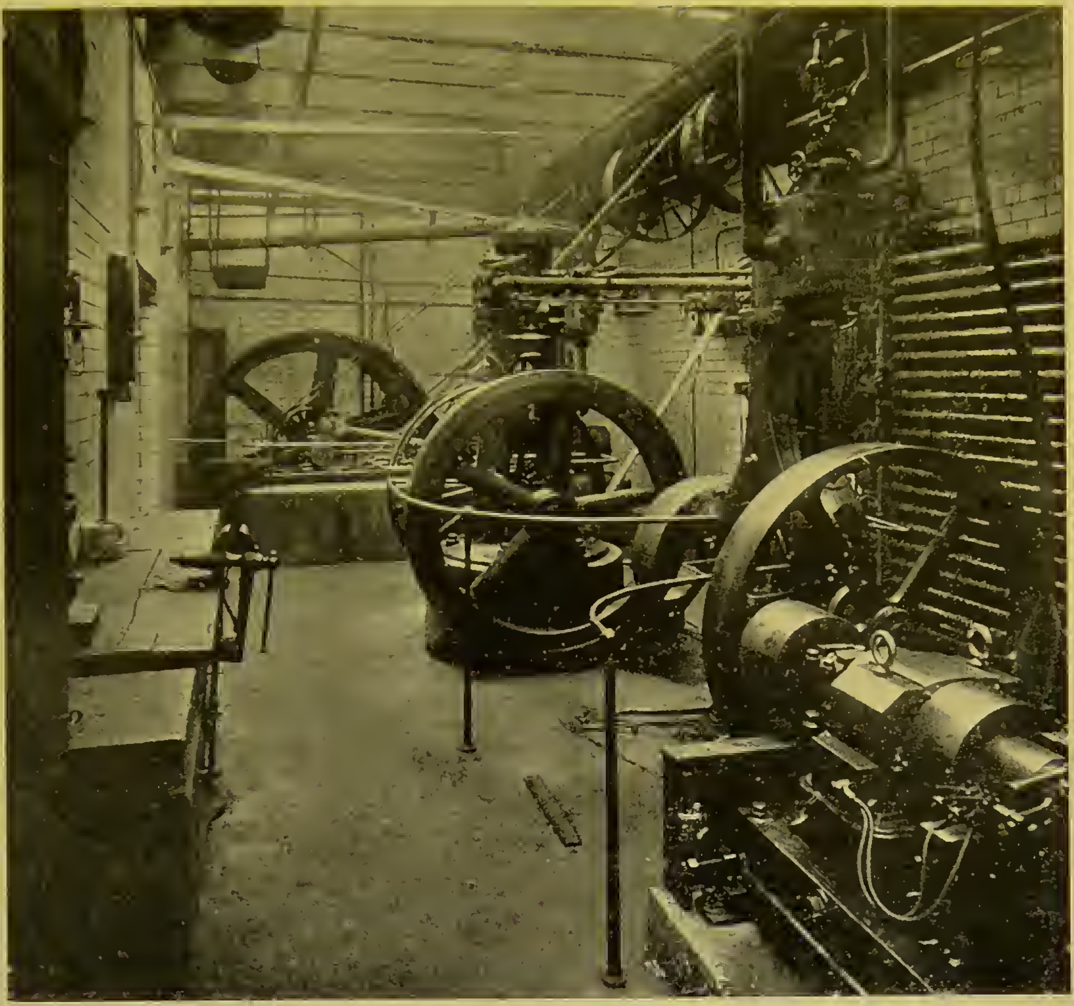
* Such a list was submitted to the Food Congress at Paris in 1909. The names of the colours sanctioned are as follows: *Rose colours:* Erythrosine, Rhodamine B; *Red colours:* Bordeaux S., New coccine, Solid red E., Bordeaux G., Ponceau 2 R., Zycidine scarlet, Acid fuchsine (without arsenic), Fuchsine (without arsenic); *Orange:* Orange I.; *Yellow:* Naphthol yellow, Chrysoidine, Auramine O; *Green:* Acid green; *Blue:* Lyons blue, Patent blue; *Violet:* Paris violet, Acid violet; *Black:* Sulphurated Indulines, Nigrosines.



THE COOKING-ROOM IN A SAUSAGE FACTORY



THE BLACK-PUDDING ROOM IN A SAUSAGE FACTORY



The Engine-room in a Sausage Factory

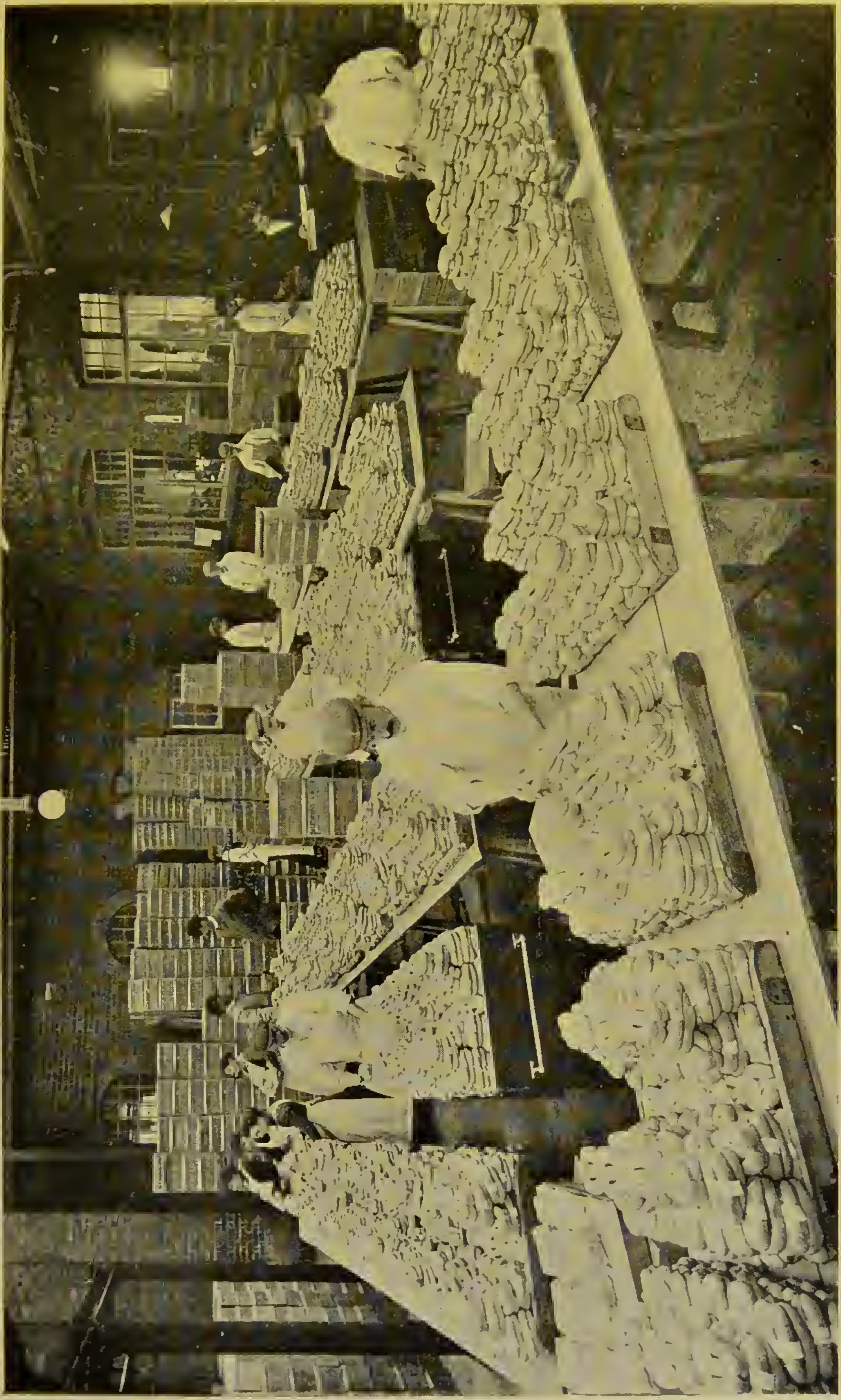
The Packing-room in a Sausage Factory

The Sausage Factory of Messrs. Palethorpe

Carmine and cochineal (in the form of extracts) are employed to a small extent in the colouring of sausage-meat.

Staining the Skins. Another purpose to which dyes are put is for staining the skins of certain sausages ; at one time camwood was much used for dyeing ham, chicken and tongue, and polony sausage casings, and logwood for neutralising the brownish colour of blood puddings, which are wanted to look as black as possible. But these also have been swept away by the brighter or more intense anilines. Smoked sausages naturally become brown in the process of smoking, but to make the shade more uniform and lively, the skins are first coloured with Bismarck brown, either alone or with a small proportion of magenta added to tone down the yellow shade. Aniline dyes, besides giving the shade required,

Making Pork-pies in a Modern Sausage Factory



Packing Sausages in a Modern Sausage Factory (Messrs. Palethorpe's) should not penetrate the sausage skin or stain the fingers, and need to be carefully selected with these points in view. The best way to use them is to add the minimum quantity that will produce the required result to the water in which the sausages are cooked. In this way the colour is better fixed, and the shade more uniform. A rough, practical rule is to use a small teaspoonful of any of the dyes to about ten gallons of water.

How Flavourings are Made. A very important department of sausage-making is that which has to do with flavouring; good meat affords the necessary basis, and good spices the ornament and finish. The selection of the right flavours is a delicate matter, excelled in by our friends over the Channel. One excellent condiment called "French spice" contains seventeen different ingredients, every one essential. The principal elements of spices and herbs that give their flavouring properties, are what are called "essential oils" with, in some cases, aromatic resins. The proportions of these in most spices and herbs are small; one decided exception is cloves, which contain about 18 per cent. of essential oils. Very few spices or herbs, however, contain more than 3 per cent., and the proportion tapers down from this figure to a small fraction of 1 per cent. Essential oils in the pure or concentrated state have generally a harsh taste. It is rather curious that the proportion of pure essential oil, or other corresponding flavouring material, in flavoured foods or drinks, varies within quite narrow limits. This is true of such diverse substances as whisky, brandy, wines and sausages. The proportion of pure flavouring material which most pleasantly affects the palate seems to be from about one-tenth to one quarter per cent. With this in mind, and knowing the proportion of essential oils, &c., in each of the spices and herbs employed, it is quite easy to calculate the total amount that should be used. To determine the quality of the flavouring, however, is another matter, which requires great experience and skill, and a special aptitude. Fortunately, very few people are called upon to devise special flavourings; the practice is to adopt a formula which has been handed down in the trade, or which may be the property of a narrower circle. There is not much encouragement to try anything new in he way of flavourings, as the public are apt to grow suspicious when goods have a different taste from that which they have been in the habit of associating with them. The smaller sausage-makers especially meat-purveyors, now generally buy ready-made complete sausage-seasonings which contain salt, pepper, spices, herbs and colouring: when required. This is a considerable convenience and when seasonings are made wholesale, it pays the maker to put down special machinery for the purpose, and buying the spices largely he has it in his power to offer a high-class article. The larger sausage-makers and a great many of the pork-purveyors prefer to make their own seasonings; they naturally regard it as a very important matter, and desire to have it entirely under their own control.

Ingredients in the Seasonings. The principal ingredients used in the corresponding sausage-seasonings, are the following:

View in Workroom of an English Sausage Factory, showing various Machines used

Salt, which must be of fine quality. Either table or dairy salt is the most suitable.

Pepper. White and black pepper have the same origin, the difference being that the former has had the skin removed by maceration in water leaving only the hard central "corn." It is much more used than black pepper in sausage-making, as the latter somewhat spoils the appearance of light-coloured sausages. The majority of sausage-makers buy their

Sausage-making in an Irish Bacon Factory pepper ready ground, but a good many have small pepper-mills, and grind the corns themselves, in this way securing the delicate aroma which is volatile, and gradually evaporates from ground pepper.

Cayenne, *capsicums* and *chillies* are the basis of red pepper, the "paprika" of the Hungarians, which varies in strength according to the variety or varieties entering into its composition. It is not so popular in this country as in several continental countries and India, but it is used to a limited extent in sausage-making where extra pungency is required.

Nutmeg is the most important spice used in sausage-making, and frequently the only one used, together of course, with pepper. Special machinery is required for grinding nutmegs, and it is commonly bought in the ground state, but those who have pepper-mills can grind their nutmegs by first breaking them up roughly in an iron mortar, then mixing them with the pepper-corns, and grinding all together in the mill. Small nutmegs are much cheaper than large ones, and, for the purposes of the sausage-maker, quite as good.

Mace, the enveloping covering of the nutmeg, is a delicate spice, pretty extensively used in sausage-making. It is soft, and like nutmegs, very oily, and the same remarks as to grinding apply in both cases.

Ginger is used by many sausage-makers ; it is very difficult to grind fine, requiring for this purpose very heavy edge runners, and is practically always bought in the ground state. The Jamaica qualities are expensive, and the cheaper Cochin and African sorts are quite suitable.

Pimento, otherwise known as allspice or Jamaica pepper, is a useful and much-used spice. It is very dry and easily ground, but, as a rule, is supplied in the ground state, as a finer grist is preferred than can be obtained from the steel pepper-mill.

Corianders. A companion spice to pimento, and about as much used. Almost always bought in the ground condition.

Cloves, as already hinted, is by far the strongest of the spices, and one to be used with great caution, but giving excellent results in the right proportions. They are very hard to grind, and are generally bought ready prepared.

Other spices used occasionally for special purposes are: caraway seeds, aniseed, cassia, cinnamon, cardamoms, cummin, fenugreek, fennel and celery seeds.

The leaves of flavouring herbs are much used in pork sausages, black puddings, &c., and the following is a list of the more important.

Sage. English sage leaves are all that could be desired in the growing state, but they are generally badly cured, and far too high a price is demanded for them. Consequently, foreign sage, grown largely at Grasse, has taken the place of the native article to a very considerable extent. For light-coloured sausages, sage leaves are never used in the finely ground form, as a dirty greenish colour would be the result. The leaves are rubbed through a sieve with, say, $\frac{1}{8}$ in. holes, and the small pieces thus obtained are used in sausage flavouring as "rubbed sage." The same remark applies to all the other herbs.

Marjoram is frequently used in conjunction with sage. A common proportion is two of sage to one of marjoram. The foreign-grown article has in this case also largely supplanted the native product.

Mint. The green garden-mint is used a good deal in the flavouring of black puddings.

Pennyroyal is used also for black puddings.

The other herbs which are mostly made use of in mixtures are: basil, lemon and common thyme, parsley, rosemary and savory. For flavouring black puddings the herbs are usually ground into a fine flour in edge runner mills.

Lemon in the form of oil and essence is used to some extent in sausage seasoning.

The composition of the different sausage seasonings will be dealt with later on, but at this point it is advisable to complete the general discussion of flavourings by giving what may be called "skeleton tables" showing the proportions in which the complete seasonings should be built up. The best general formula for a complete sausage seasoning, we may express as follows: For every part of pepper, use two parts of salt, and flavour with 5 to 10 per cent. of spices, and herbs when used, to be extra. In accordance with this formula, we will work out two complete seasonings:

Beef Sausage Seasoning.

White Pepper	31 per cent.
Salt	62
Spices	6
Colour	1
	100

Use ½ oz. per lb. of sausage-meat including bread, *i.e.* the bread must be seasoned as well as the meat.

Pork Sausage Seasoning.

Pepper	30 per cent.
Salt	60
Spices	5
Herbs (sage and marjoram)	5
	100

Use ½ oz. per lb. as in beef sausage.

If the sausage-maker adheres to these formulæ, and sticks to a mixture of the following spices, viz., nutmeg, mace, ginger, pimento and coriander, using a preponderance of nutmeg, he will not go far wrong.

The sausage-making process, already described, covers all ordinary sausages, such as beef, pork, luncheon, German, &c., but for some other varieties special processes are necessary. In the case of ham, chicken and tongue sausages, the chopped meat is cooked, then wrapped up in a thin slice of pig's back fat, and slipped into the soaked weasand which is used as a container; each end is then firmly tied with twine and the sausage is suspended in hot water to consolidate its contents. The skin dye may be dissolved in this water, or a separate dye bath may be used. Black puddings are still made by hand; the blood, groats, chopped onions, ground herbs, salt and pepper, are mixed together in a large copper, and the mixture stuffed in to the skins with the aid of a funnel.

Many machines have been proposed for filling black puddings, but the weak point of them all is the difficulty of keeping the mixture uniform, the fluid nature of the blood allowing the other ingredients to separate readily.

Oatmeal and some other pudding sausages are also filled by hand.

While the proportions of the ingredients of sausages vary a good deal, according to the market value of different kinds of meat, and individual tastes and idiosyncrasies, the following recipes may be taken as fairly representative of all the sausages made to any extent in this country. Of course we are not able to follow all the innumerable local varieties which are in existence.

Pork Sausage.

Lean pork	15 lb.
Back fat	6 ,,
Soaked and pressed bread, or Soaked biscuit powder	4 ,,
Seasoning (as under)	14 oz.
Food preservative	2 ,,
Sufficient colour.	

Seasoning.

White pepper	5 oz.
Salt	8 ,,
Ground nutmeg	¼ ,,
Ground ginger	¼ ,,
Rubbed sage	½ ,,
	14 ,,

The meat to be chopped first with the preservative and seasoning, then the bread is added and chopping continued, and finally the back fat is added, and all chopped together. Filled into medium width hog casings; lengths of 1 lb. to be cut off, and made up into six links. The linking is done by twisting the 1-lb. length over on itself in six places at equal distances, then making up neatly into a bundle. The knack of making up a tradesman-like bundle is only acquired by experience.

To make a cheaper sausage the quantity of bread or biscuit powder can be increased, and most makers use about double the amount shown in the above recipe.

Cambridge Sausage.

Lean pork	12 lb.
Back fat	6 ,,
Scalded rice	3 ,,
Biscuit powder	2 ,,
Food preservative	2 oz.

With seasoning as under.

Seasoning.

White pepper	6 oz.
Salt	12 ,,
Ground nutmeg	$\frac{3}{8}$,,
Ground mace	$\frac{1}{4}$,,
Cayenne	$\frac{1}{16}$,,
Rubbed sage	$\frac{1}{4}$,,

The scalded rice is made by mixing granulated rice with from three to three and a half times its weight of boiling water, stirring it up, and then allowing to cool.

Sometimes veal is substituted for part of the lean pork. Filled into medium hog casings.

Beef Sausage.

Lean beef	12 lb.
(A bullock's heart may be added in place of an equal weight of lean beef.)	
Beef fat	8 ,,
Steeped and pressed bread	4 ,,
Biscuit powder	4 ,,
Food preservative	2 oz.

Sufficient colour.
Seasoning as under.

Seasoning.

White pepper	$4\frac{1}{2}$ oz.
Salt	9 ,,
Nutmeg	$\frac{1}{4}$,,
Ginger	$\frac{1}{8}$,,
Coriander	$\frac{1}{8}$,,
Pimento	$\frac{1}{8}$,,
Cloves	$\frac{1}{8}$,,

If the biscuit powder makes the mixture too dry, sufficient water is added to bring it up to the right consistency. In the north of England and Scotland, beef sausage is filled into sheep casings, but in the south, hog casings are used.

Ham, Chicken, and Tongue Sausage. As already hinted, it is not the custom to put chicken meat into these sausages, although a few makers put the meat of a chicken into the following quantities of ingredients, for the sake of appearances :

Pork	10 lb.
Veal	4 ,,
Ox tongue	2 ,,
Fat	4 ,,
Scalded granulated rice	4 ,,
Biscuit meal	2 ,,
Preservative	2 oz.
Seasoning, made in the proportion stated below	12 ,,

The addition of 6 eggs is an improvement.

Seasoning.

Salt	56 per cent.
White pepper	37 ,,
Ground mace	3 ,,
Ground parsley	3 ,,
Ground thyme	1 ,,
	100 ,,

The pork, veal and tongue are cut into 2-in. pieces. The rice and then the other ingredients are added, and the whole chopped very finely in the machine. The mixture should then be cooked in covered pans placed in water, and heated to about 200° Fahr. for an hour. Thin slices of pig's back fat are cut off and trimmed to the proper size, and sufficient of the sausage-meat placed in each slice, so that when it is rolled up it fits just nicely into the previously steeped weasands. These are tied at both ends and the sausages hung in hot water (200° Fahr.) for ten or fifteen minutes to set. They are then dipped in ham, chicken and tongue dye—a scarlet aniline, with a pink shade in it.

Smoked Sausages (*German or Luncheon Sausage*).

Beef	18 lb.
Salt trimmings	12 ,,
Back fat	12 ,,
Farinaceous material	14 ,,
Water	10 ,,
Preservative	8 oz.

Seasoning as under.

Seasoning.

White pepper	5½ oz.
Saltpetre	3 ,,
Ground mace	1 ,,
Ground nutmeg	1 ,,
Ground ginger	2 ,,
Ground cinnamon	½ ,,
Sugar	1 ,,

Some colouring may be added.

The above recipe is very extensively used. The back fat is cut into cubes, either by hand or by the fat-cutting machine, and is added after the other ingredients have been chopped, so that the pieces of fat will show all through the sausage. To be packed into previously steeped bungs, by the ordinary sausage-filler with wide nozzle. The ends are tied up, and the strings form suspensory loops, with additional strings or netting round the middle to support the heavy sausage. It is then cooked for an hour in water at 180° Fahr., falling to 170° Fahr. In this water some Bismarck brown or smoke dye may be placed to improve the colour of the skin. They are then hung up in the smoke chamber for twelve or sixteen hours.

German Sausages in Weasands. These are of better quality as a rule than the large Germans, and sell at a better price.

Lean pork	8 lb.
Fat pork	8 ,,
Scalded granulated rice	2 ,,
Biscuit meal	2 ,,
Preservative	2 oz.

Seasoning as under.

Seasoning.

Salt	4 oz.
White pepper	2½ ,,
Ground cayenne	¼ ,,
Ground nutmeg	1¾ ,,
Ground mace	1½ ,,

Cut the pork into small pieces and chop lightly with the scalded rice, adding the biscuit meal, seasoning and preservative, and chopping very fine. Fill into weasands and cook for an hour in water at 200° Fahr., adding some Bismarck brown or smoke dye to the boiling water. Then finish off in the smoke oven. In some parts of the country these sausages are not smoked, but dyed scarlet or dark red. In Yorkshire a somewhat similar sausage is called the "polony," but it is filled into beast runners instead of weasands, put up in a circular form and dyed a bright scarlet.

Smoked Pork Sausages.

Pork	16 lb.
Fat	5 ,,
Bread	7 ,,
Biscuit powder	3 ,,
Preservative	2 oz.

Seasoning as under.

Seasoning.

Salt	10 oz.
White pepper	5 ,,
Ground nutmeg	½ ,,
Ground corianders	1 ,,
Ground cayenne	½ ,,

Fill into medium hog casings, cook in water at 200° Fahr., with some smoke dye, and finish in smoke oven.

Saveloys. Generally made from all kinds of cheap and offal meats, such as weasand meat, lights, second quality of salt pork. They are sold cheaply, but this may be done and a good article produced at a profit.

Beef	16 lb.
Fat	4 ,,
Pressed bread	8 ,,
Biscuit powder	4 ,,
Preservative	2 oz.
Saltpetre	1 ,,

¼ teaspoonful of Armenian Bole.
Seasoning as under.

Seasoning.

Salt	8 oz.
White pepper	5½ ,,
Ground coriander seed	3½ ,,

Filled into medium hog casings, and cooked and finished like smoked pork sausages.

Black or Blood Puddings.

Midlothian groats	10 lb.
Leaf lard or back fat	10 ,,
Blood (bullocks' or pigs')	2 gals.

3 or 4 onions chopped fine, if the onion flavour is desired.
Seasoning as under.

Seasoning.

Salt	6 oz.
Ground mixed herbs	5 ,,
Ground black pepper	5 ,,
Ground pimento	1 ,,
Ground coriander seed	1 ,,

1 teaspoonful rubbed pennyroyal.

Cook the groats, and cut the fat into small cubes. Mix all the ingredients together in a tub or copper, and fill by hand or by the aid of a small wide-necked funnel, into beast runners previously steeped in water. Tie into pieces of from 12 to 18 in. in length, and form into circles. Cook in water at 180° Fahr., for about half an hour, adding a little blue-black aniline dye to the water, or 1 lb. of logwood to every fifteen gallons. Sometimes pearl barley is used instead of groats.

White Puddings.

Fine oatmeal	10 lb.
Beef suet	7 ,,
Ground white pepper	2½ oz.
Fine powdered salt	2 ,,

Chop up the suet after freeing from skin, &c., into pieces of about ¼ in., and mix all the ingredients together in a basin. Fill loosely into narrow runners or middles, tie as in the case of black puddings, and cook for half an hour in water at 180° Fahr. No dye is used.

Cornish Hog Puddings are made from :

Pork	20 lb.
Bread	6 ,,
White pepper	2 oz.
Salt	6 ,,
Thyme (rubbed)	½ ,,
Parsley	½ ,,
Nutmeg	¼ ,,
Food preservative	¼ ,,

The pork should consist of two parts lean to one part fat ; all chopped fine and filled into beef middles and made into sausages of 1¼ to 2 lb. each. To be cooked for forty-five minutes at a temperature of 170° Fahr.

The foregoing may be regarded as a list of the standard sausages made in this country. For comparison, we append a few recipes of foreign sausages :

Beef Cervelat Sausage. Use fresh lean beef (100 lb.) from which all the blood has been thoroughly drained, dry with a clean cloth. Then add 30 lb. of fresh fat pork, chop together finely, and mix with it 35 oz. of salt, 3 oz. of ground saltpetre, 35 oz. ground white pepper and 1 oz. whole white pepper. Stuff tightly into beef middles, tie into sausages, 10 in. long, hang in an airy place for eight days, then smoke for six days. In winter, if exposed to the air, they will keep six weeks without smoking. A beautiful red colour may be given to the Cervelat sausage by heating the salt and saltpetre together, and adding to this mixture ½ oz. cochineal. Reduce all to a fine powder before mixing with the meat. If the sausages are too light in colour, it may be inferred that the meat is of an inferior grade.*

Pork Cervelat Sausage. From a young hog take 70 lb. lean meat, 30 lb. fat meat, chop fine and mix with 31 oz. salt, 3 oz. pulverised saltpetre, 6 oz. ground white pepper, 1½ oz. whole white pepper. Stuff tightly into hog bungs or beef middles. Hang in a cool place from eight to twelve days, then smoke six to eight days. Should the sausage become white in the course of time, it can be cleansed with a woollen cloth dipped in lard. In winter they may be kept from four to six weeks without being smoked. If made of coarsely chopped meat, they will remain juicy much longer than otherwise.*

Spegepolse, or Danish Smoked Sausage. The sausage most extensively used in Denmark. It consists of :

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* *Douglas' Encyclopædia.*

Beef	50 lb.
Pork	50 ,,
Fat, chopped fine	20 ,,
Fat cut to $\frac{5}{16}$ in. cubes	16 ,,
Fine salt	5 ,,
Saltpetre	2 oz.
Fine white sugar	5 ,,
Ground white pepper	6 ,,

Extract sinews, and chop up beef and pork together. When half chopped, add fat and spices, &c., and chop all together. After chopping mix with the $\frac{5}{16}$ in. cubes of fat, and pack tightly in a wooden trough, and allow to stand for twenty-four hours, to enable the saltpetre to develop colour, and firm the mass. Fill as tightly as possible into ox or horse runners. The sausages are then laid in a pickling-vat, and sprinkled with coarse salt, boards being placed on them. When the salt has turned to pickle, the sausages are taken out and hung up in the air to dry, and then smoked until they are of a deep brown colour. Length about 18 in. Will keep for several months. Usually eaten raw.

Frankfort Meat Sausage. The Frankfort meat sausage (Frankfürter, Fleischwurst) is made purely of pork. The hind-legs, fore-legs and belly of the animal may be used.

Take the finest, firmest quality of pork to be had from light, young pigs. If it is impossible to have it all pork, one-third beef may be used, but all pork is better. Take 20 lb. of good pork, if possible, and mince to the size of chestnuts, add $\frac{3}{4}$ lb. salt, then add a little water, and mince to the size of hazel-nuts. Add 1 oz. white pepper, $\frac{1}{4}$ oz. nutmeg, 3 sticks of garlic, 2 sticks of eschalots (finely grated), then mince until the meat is as fine as grains of rice, and throw the meat about from right to left on the block several times, but be careful not to knead with the hands. Now put the meat in narrow salted bullock runners, 2 to 3 in. long, fill them very tightly, tie them up, let the sausages lie from eight to ten hours to dry, and smoke them in a temperature of 64° to 68° Fahr., letting them hang until they are of a yellowish red colour, and then boil from twenty-five to thirty minutes. They can be allowed to hang in the smoke-room until they are required, and then boiled, or they may be boiled as soon as they are ready: they may be eaten either warm or cold.*

Garlic Sausages.

Veal	12 lb.
Lean ham	12 ,,
Fat pork	12 ,,
Farina	4 ,,
Water	5 ,,

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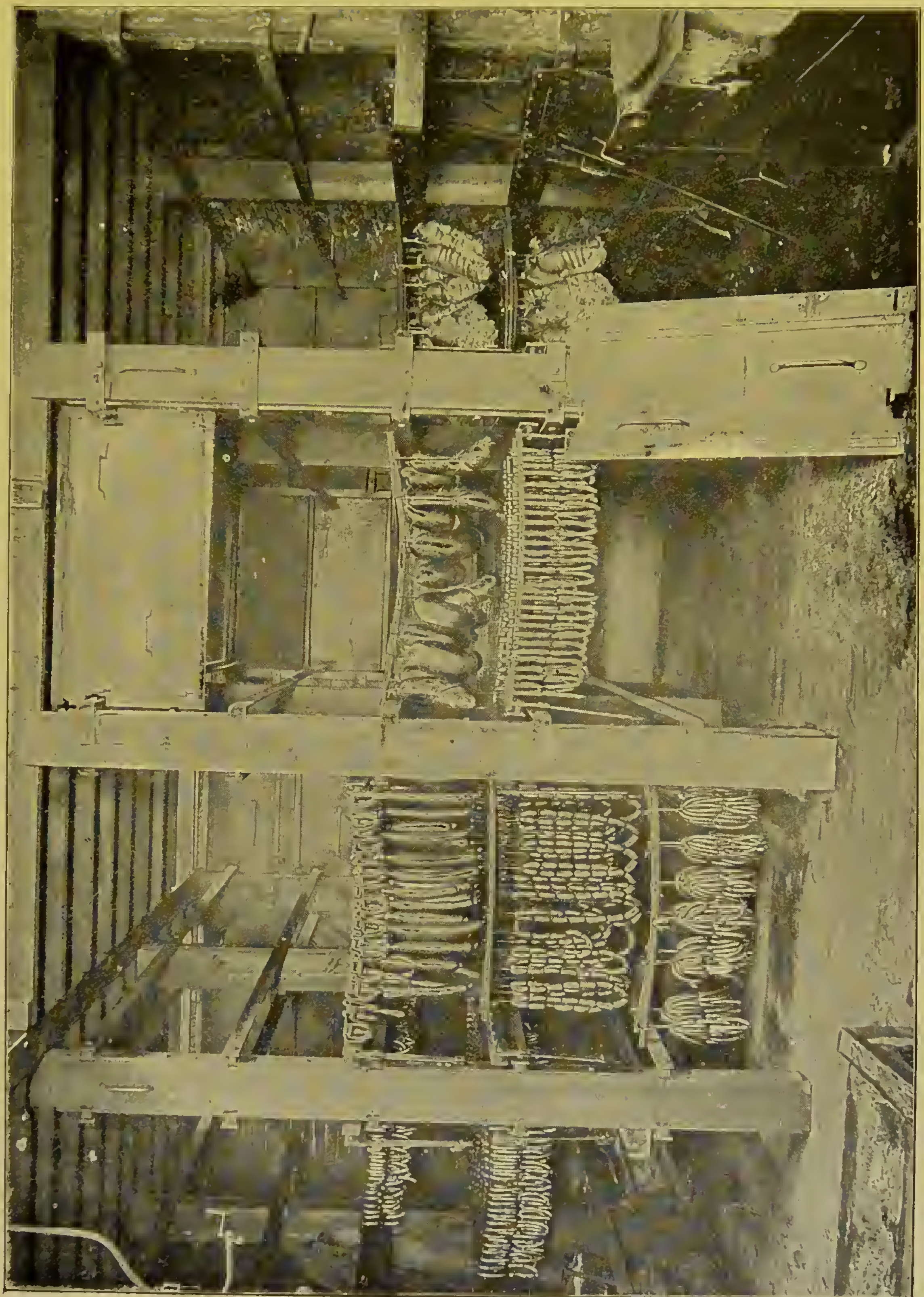
* *Douglas' Encyclopædia.*



German Sausage Factory Store-room

Seasoning.

White pepper	5 oz.
Mace	1 tablespoonful.
Ginger	1 teaspoonful.
Garlic	4 cloves.

Chop the meat and fat and seasoning together; add the farina and water; mix well and fill into weasands. Smoke for two hours, then cook for fifty minutes at a temperature of 180° Fahr.

Liver Sausage. Take 100 hogs' livers (you can, without doing any harm to the sausage, take to every two hogs' livers, one calf's liver). Cut them in slices, take the blood vein and fibre out, put in a tub, and scald with hot water; repeat this operation until the livers look clean and white: chop the whole, then add 12½ lb. of fat from the intestines, which should be boiled half an hour before, mixing with the balance; then chop the whole once more. Add 5 lb. fat pork, cut into small pieces, boil the whole half an hour, then mix with the following spices: 7 oz. salt, 1 oz. ground marjoram, ½ oz. ground sage, ½ oz. ground thyme, 2 oz. ground pepper, ½ oz. basil.

To increase the amount besides using livers, you may use veal from the head, the kidneys, and other parts of veal that are not readily saleable. Stuff in hog casings or beef rounds. Cut into lengths of from 11 to 13 in. Boil for thirty minutes in the broth which was obtained from the preparation of the meats. If the sausages are large, boil perhaps thirty minutes longer. During the boiling the sausages should be continually turned with a wooden ladle, and pricked with a fork or other sharp instrument. After removing, immerse for four or five minutes in clear cold water. If these sausages are cooled too slowly, the fat will not be distributed equally among them, but will have a tendency to collect on the upper side.

After cooling, the sausages should be hung in the open air from ten to twelve hours in summer, and from two to three days in winter, when they are then ready for smoking, which must be continued for six days.*

Mortadelle. This sausage is always in request, and can be prepared and kept even in summer, and so always fetches a good price. For 30 lb. take

Pork, very lean, from a very young pig	17 lb.
Lean young beef, from leg or neck	8 ,,
Fresh back fat, cut into cubes ¼ in. size	5 ,,

Take the lean meats and chop them up, and add 1 lb. fine salt, 1¼ oz. Indian cane sugar, ¾ oz. saltpetre.

Put it all in a stone jar pressed tightly together, and keep for two days covered up. Then take out, chop quite fine, and season with 1¼ oz. fine white pepper, ⅓ oz. fine white ginger, ⅓ oz. mace, three sticks finely grated and salted eschalots; then add 2 or 3 lb. of raw veal and chop all together again. Now put in a dish, adding a little water, and mix

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* *Douglas' Encyclopædia.*

PLATE XII

SAUSAGES OF VARIOUS TYPES

14 and 15. Liver Sausage
16 and 17. Veal and Ham Sausage
18 and 19. Pork Weasand Sausage
20. Tomato Sausages
21. Smoked Sausages
22 and 23. Cornish Hog Pudding
24. Beef Sausages
25. Cambridge Sausages
26 and 27. Irish White Puddings
28. Pork Sausages

A mixture of fresh and preserved sausages. Nos. 14 and 15 are the liver sausages so popular in Germany. Nos. 16 and 17, a veal and ham sausage, similar to the garlic sausage (*see* recipe) but without the garlic. Nos. 18 and 19, a pork weasand sausage similar in composition to the polony. Nos. 22 and 23, Cornish hog puddings, and Nos. 26 and 27, Irish white puddings of similar composition. The ordinary fresh pork sausage, No. 28, should be eaten when quite fresh. Other uncooked sausages are No. 25, Cambridge sausage, No. 24, beef sausage, No. 20, tomato sausage, which is pork sausage flavoured with tomato conserve. No. 21 is smoked sausage, being pork sausage cooked and smoked.

We are indebted for the specimens of the various illustrations shown in this plate, and from which the drawings have been made, to the following:

To Messrs. Samsons, Ltd., of London, for the liver sausage, veal and ham sausage, and the pork weasand sausage.

To Messrs. Annacker and Co., Ltd., Glasgow, for the tomato sausages, smoked sausages, and pork sausages.

To Mr. Tonkyn, Truro, for the Cornish hog pudding.

To the Co-operative Bacon Factory, Roscrea, County Tipperary, Ireland, for the Cambridge sausages and the Irish white puddings.

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well together, then knead it all for a quarter of an hour. Add the pieces of fat, and work all together for another quarter of an hour. See that the fat is equally mixed throughout, then throw it from hand to hand until it is quite firm. Put into the filling-machine, and see that no air gets in. See that the skins are well salted and well dried, about 12 to 15 in. long and very narrow. Dry the sausage well in winter for forty-eight hours in a room warmed to a temperature of 77° Fahr. Smoke with beech and oak sawdust into which a few juniper berries have been thrown. Let them hang until they are of a cherry-red colour, then let them simmer, *not* boil, for about one and three-quarters to two hours.

A sure sign of the mortadelle being ready is this : if they are taken out of the pot, and the water dries off the skin at once, then they are ready ; if not, put them back in the pot. Whenever they come out of the pot, roll them up in big napkins until they are perfectly cold, when they will be crab-red, which colour they will not lose.*

Salami. Use 50 lb. of beef free from fibre, 25 lb. of lean pork, 25 lb. of fat pork ; chop very fine and add 18½ oz. of salt, 4½ oz. ground white pepper, 1½ oz. saltpetre, with 8 glasses of Rhine wine, in which previously has been soaked about 1 lb. of garlic ; in place of Rhine wine, rum may be used. Stuff in calves' bladders. Let them hang in the open air for two or three weeks, then smoke 12 days.*

Spanish Sucking-pig Sausage. Take a sucking-pig, about eight weeks old, and remove all the bones and rind, and chop up all the meat pretty fine. Add to this an ox tongue, or several pigs' tongues, which have been skinned and cut into dice, also three or four well-beaten eggs, salt, pepper and mace to taste, some grated lemon rind, one or two tablespoonfuls of capers, some ginger, and a glass of good Madeira. Mix all these ingredients thoroughly, and, if the paste is too stiff, add a little water. Cut some large slices, about ⅙ in. thick, from the breast of a pig, and lay them all over the paste, then sew them together, making one large sausage. Roll the sausage in a clean cloth, fasten at both ends, and at the middle. Boil from one to two hours, according to size, boiling gently. Lay on a table to cool, letting the string and cloth remain for twenty-four hours.*

Vienna Sausages.

Lean veal from neck or leg	10 lb.
Streaked pork from a young animal . .	10 ,,

If preferred 15 lb. of one kind of meat and 5 lb. of the other may be taken, or whichever is the cheaper for the time being. Two-thirds veal, and one-third pork are very good, as they make the sausage such a nice colour. Before chopping the meat, both pork and veal should be treated thus : One or two days before, if possible, it should be cut into pieces like beans and then salted in the usual way with 1 lb. salt, ½ oz. saltpetre, 1 oz. white Indian cane sugar. Be sure that the brine is well rubbed into all the meat, and that the meat is afterwards pressed very closely and kept from air. In this way the sausages will be of a lasting colour, and will keep for more than a week.

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* *Douglas' Encyclopædia.*

Now chop the veal first, then add the pork: it should not be so fine as the veal. To 20 lb. of meat take 1¼ oz. of white pepper, ½ oz. finely ground corianders, one stick garlic and two eschalots, grated. Mix all well together, and add to the meat. Now add 2 to 3 lb. newly killed meat, then begin to stir round and round for half an hour, adding a little water occasionally: in winter the water should have the chill off it. Fill into not too narrow sheep-skins, hang them on sticks for some hours to get dried; in winter in a warmed room. When smoking, be careful not to let the skin get hard. The sawdust for smoking must be in a perfect glow when the sausages are hung up, and the room about 133° Fahr. They should hang twenty to twenty-five minutes, and be of a chestnut brown colour. Immediately on being smoked, they should be put into hot water and stirred round about on the stove. When they rise to the top of the water, they are ready, and should be taken out, and hung on white sticks. These sausages have been famous in Vienna since 1857.*

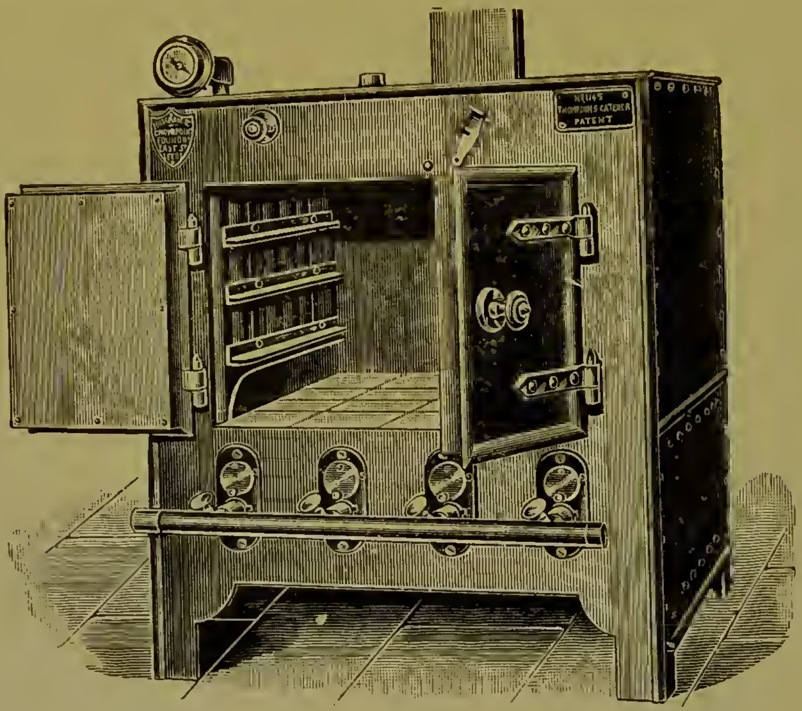


Fig. 30.—Gas-oven used for cooking Pork-pies

Pork-pie Making. A number of products besides sausages are frequently made by pork-purveyors and sausage-makers, the principal being pork pies, in connection with which there is a large industry, especially in the Midlands of England. Quite a number of machines are used in the work, including a dough-mixer for making the paste, and enamelled troughs for holding the paste and meat, separately. The meat is cut up in the ordinary sausage-machines, but it is chopped roughly so that it will stand up well in the pie.

* *Douglas' Encyclopædia.*

Paste recipe.

Flour	7 lb.
Lard	3 ,,
Salt	1 oz.
Boiling water	3½ pints.

Some prefer to add the lard hot. All to be well mixed and kneaded together.

The meat used is preferably that from legs of pork, and the composition is as follows:

Pork	12 lb.
Fat	4½ ,,
Salt	4½ oz.
Pepper	2¾ ,,

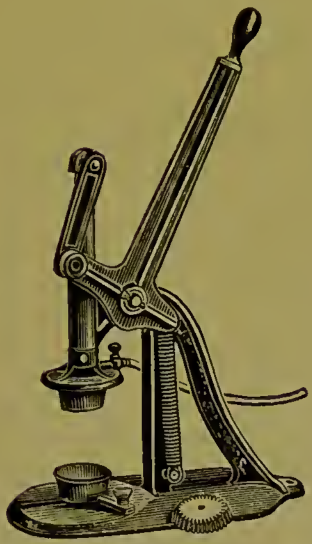


Fig. 31.—Pie-paste Moulding-machine

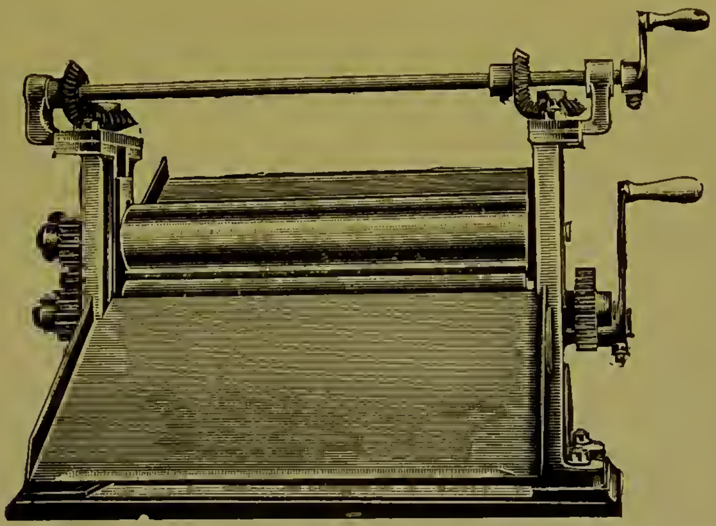


Fig. 32.—Rolling-machine for Pie-paste, generally called a "Dough-brake"

The gravy is made by boiling rinds and bones together for several hours.

The pies are usually baked in brick ovens, but portable gas or coke-ovens are largely used by the smaller producers.

Veal and Ham Pie.

Veal	12 lb.
Ham	3 ,,
Salt	3 oz.
White pepper	2 ,,
Ground nutmeg	¼ ,,
,, mace	¼ ,,
Mixed herbs	¼ ,,
Antiseptic	2 ,,

Cut the meat roughly. Paste, gravy procedure and cooking as with pork pies.

Veal, Ham, and Egg Pie. Similar to veal and ham pie, but with the addition of one hard-boiled egg for every 1 to 2 lb. of meat. The eggs are placed in the centre of the pie-meat in each pie.

Galantine. Take the bones and sinews out of a leg of veal and weigh 11 lb. of it, also 5 oz. of anchovies, removing the bones. Add the anchovies to the veal and chop up very fine together. Mix with it 4 oz. of salt, 1 oz. of ground pepper and two grated nutmegs, and make the whole into a paste with water. Then take a handful of pistachio nuts, one-eighth of a glass of French truffles cut into dice, and about 1 lb. of raw pork and the same quantity of salted and cooked tongue; both also cut into dice. Work all these lightly through the paste and cook for an hour at 180° Fahr., and then transfer into tin moulds of a suitable shape and allow to cool and set. It is better, where a steam-cooking apparatus is available, to place the raw meat in the moulds to begin with and cook in steam. After the galantine has set, it is turned out and covered with a thick jelly, made by boiling pig-rinds in water or from fine gelatine. The jelly should be coloured with caramel.

Brawn is made from pigs' heads, which are boned and slightly salted by placing for a day or so in a barrel, and dusting every layer with the following mixture:

Salt	5 lb.
Saltpetre	$\frac{1}{4}$,,
Preservative	$\frac{1}{2}$,,

The thick parts, such as the tongues at the roots, are well rubbed with the mixture. When cured the heads are washed and then cooked for an hour at 212° Fahr., adding seasoning as follows:

For twenty heads.

Ground white pepper	3 oz.
Cayenne pepper	$\frac{1}{2}$,,

A thimbleful of essence of lemon.

Strain off the jelly and cut the meat either by hand or machine into $\frac{1}{2}$-in. to $\frac{3}{4}$-in. dice. Pack into moulds and fill up with a portion of the jelly. Should the latter not be strong enough to set properly, some good gelatine may be dissolved in it.

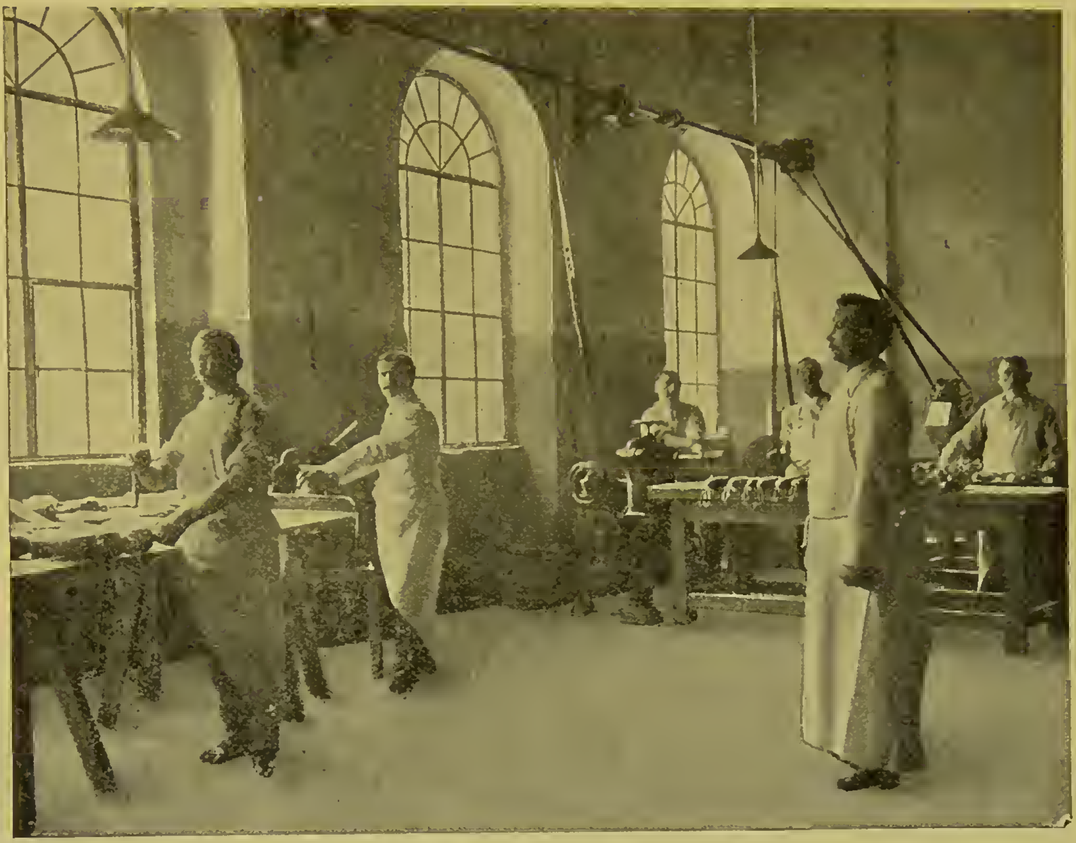
SAUSAGE-MAKING IN GERMANY

VIEWS IN A WELL-EQUIPPED MODERN FACTORY

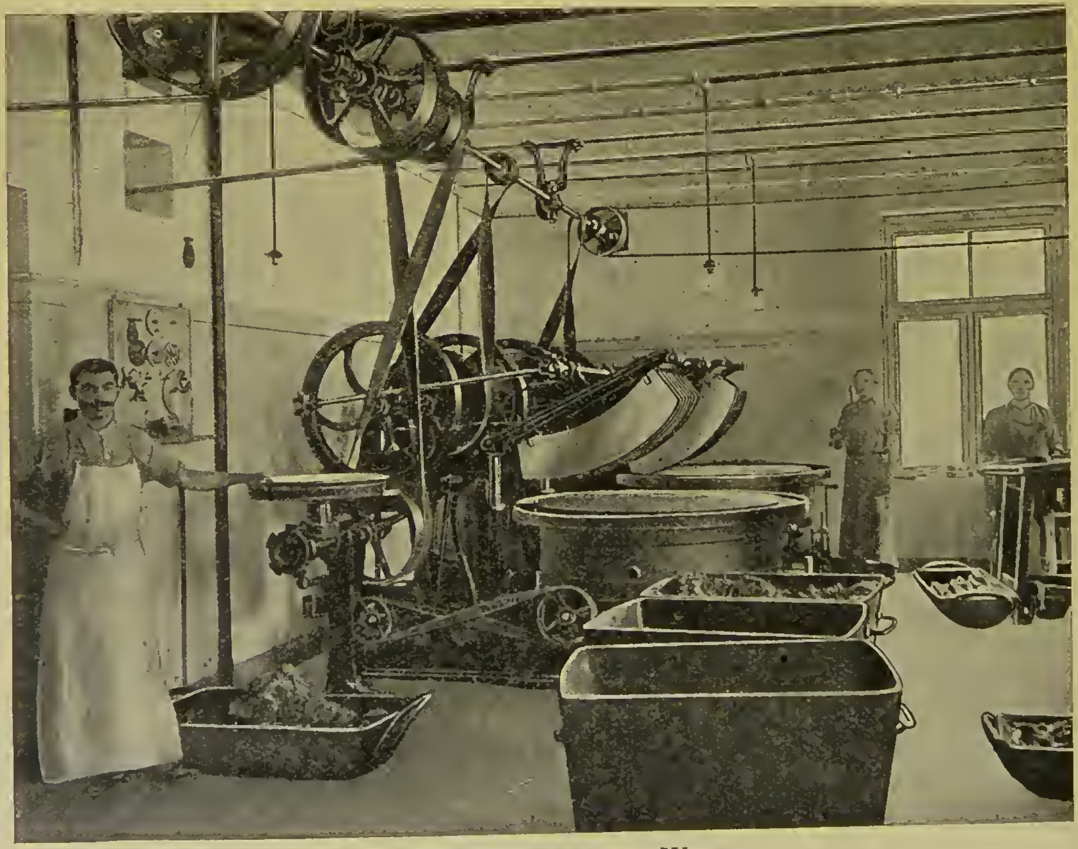
Aug. Scheere
Thüringer-Wurst- Fleischkonservenfabrik Aug. Scheere
Thüringer Wurst- u. Fleischkonservenfabrik

Exterior View of a Sausage Factory

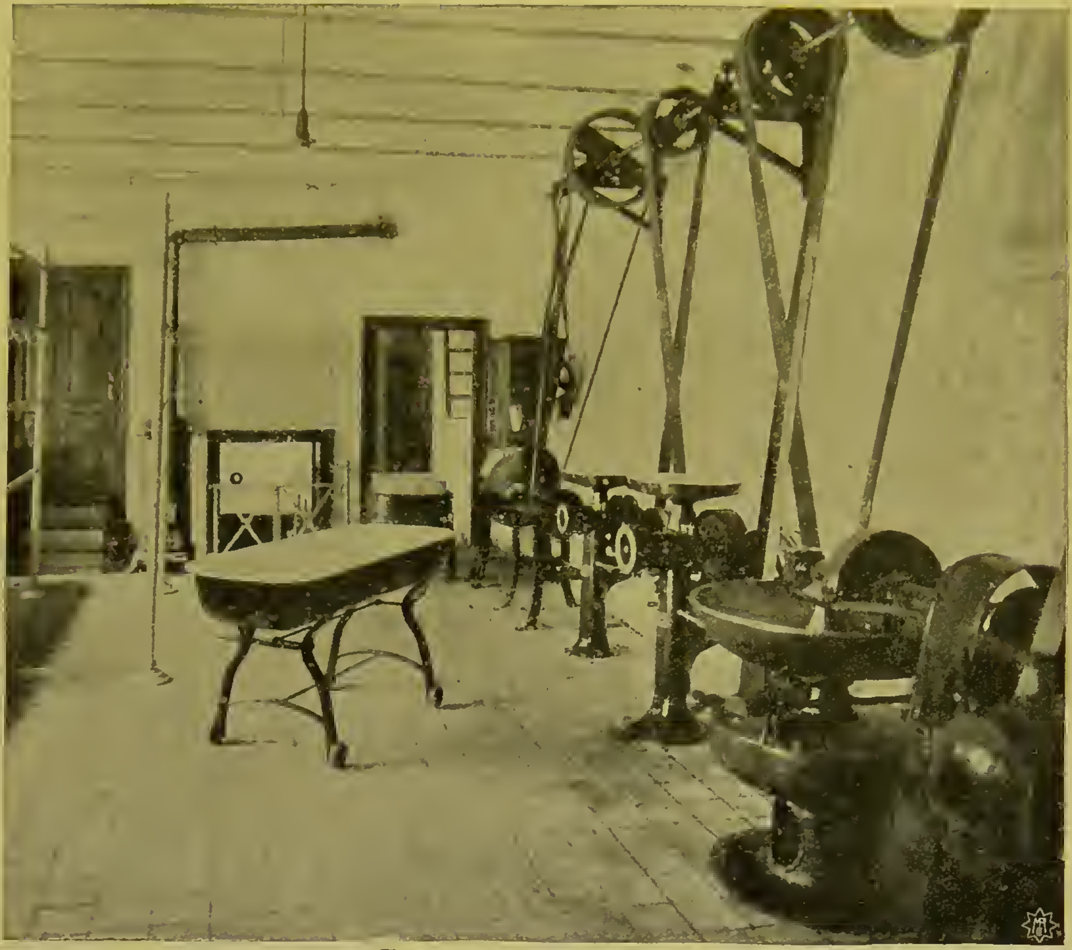
View in Courtyard of Sausage Factory



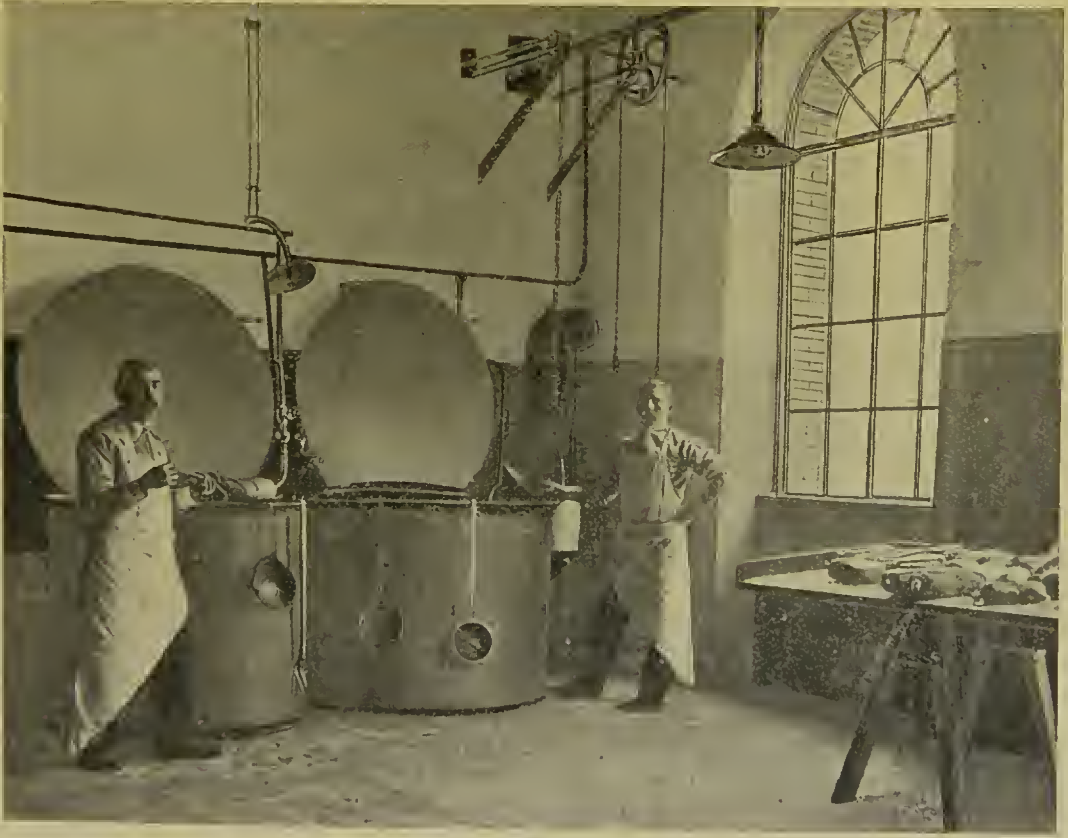
View showing Boning-table



Rocker Choppers at Work



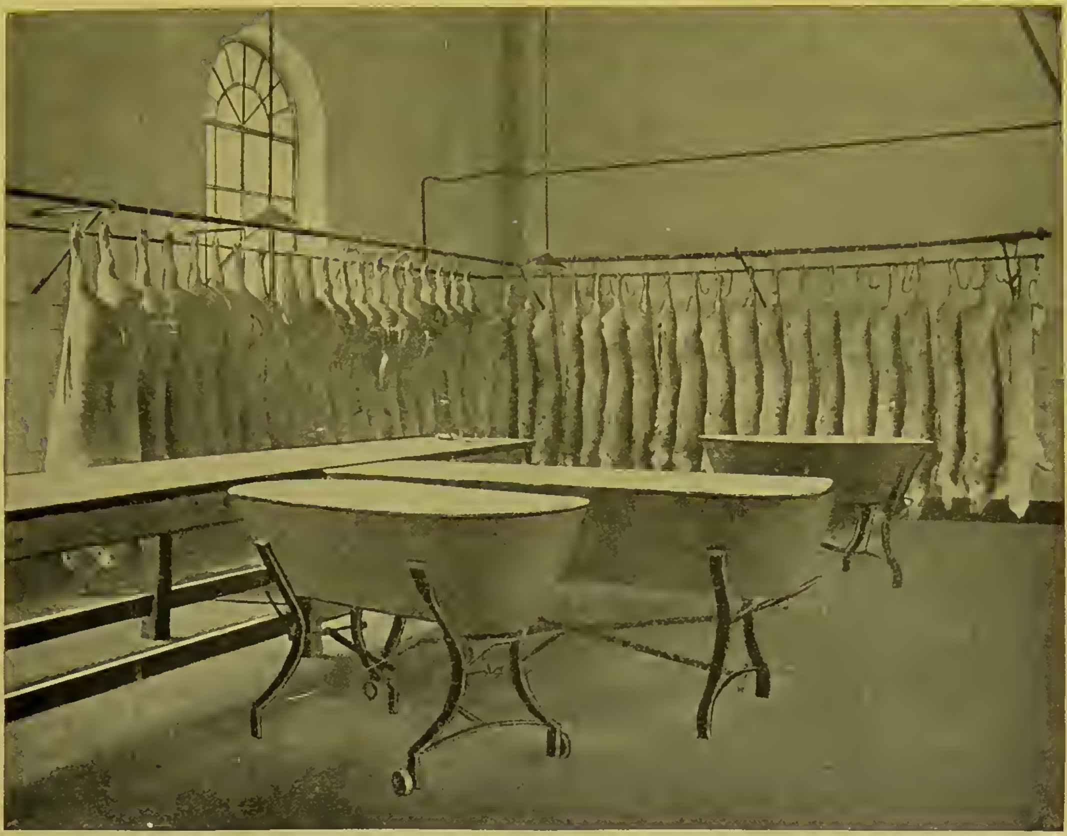
The Alexander Cutters



Cooking-pans

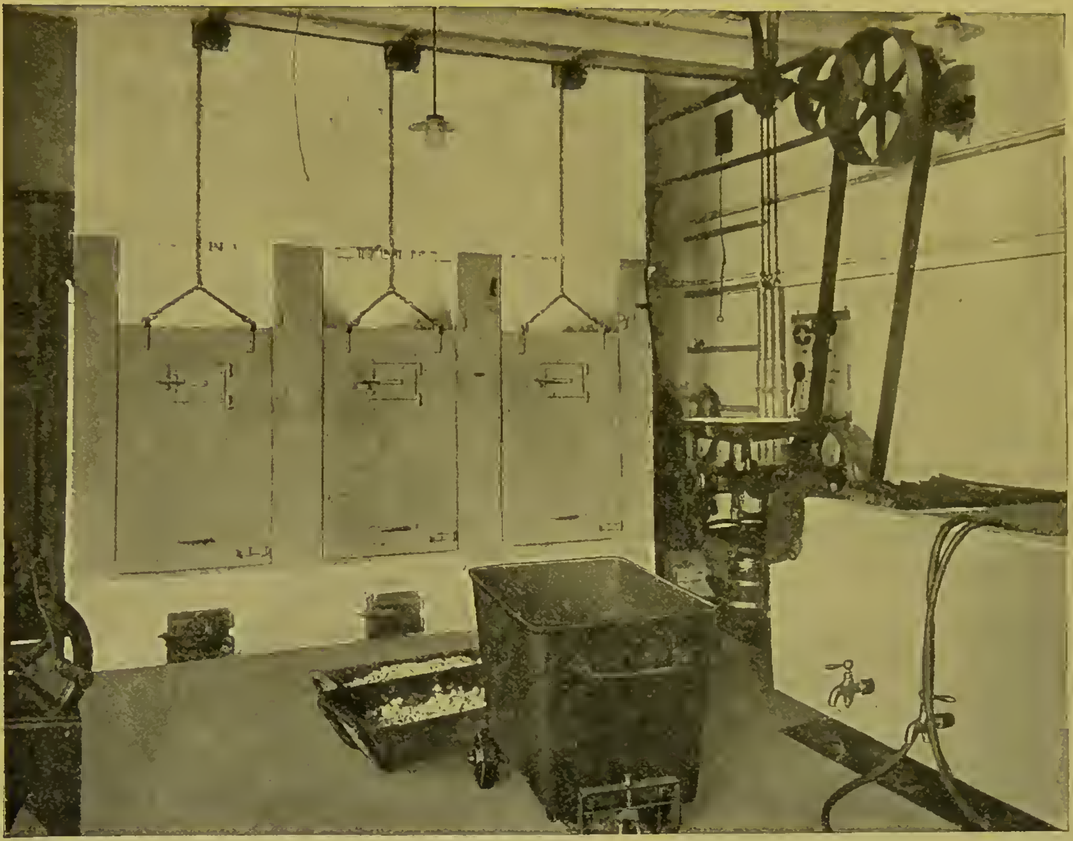
ANOTHER VIEW OF COOKING-PANS

THE MEAT-STORE OF THE FACTORY

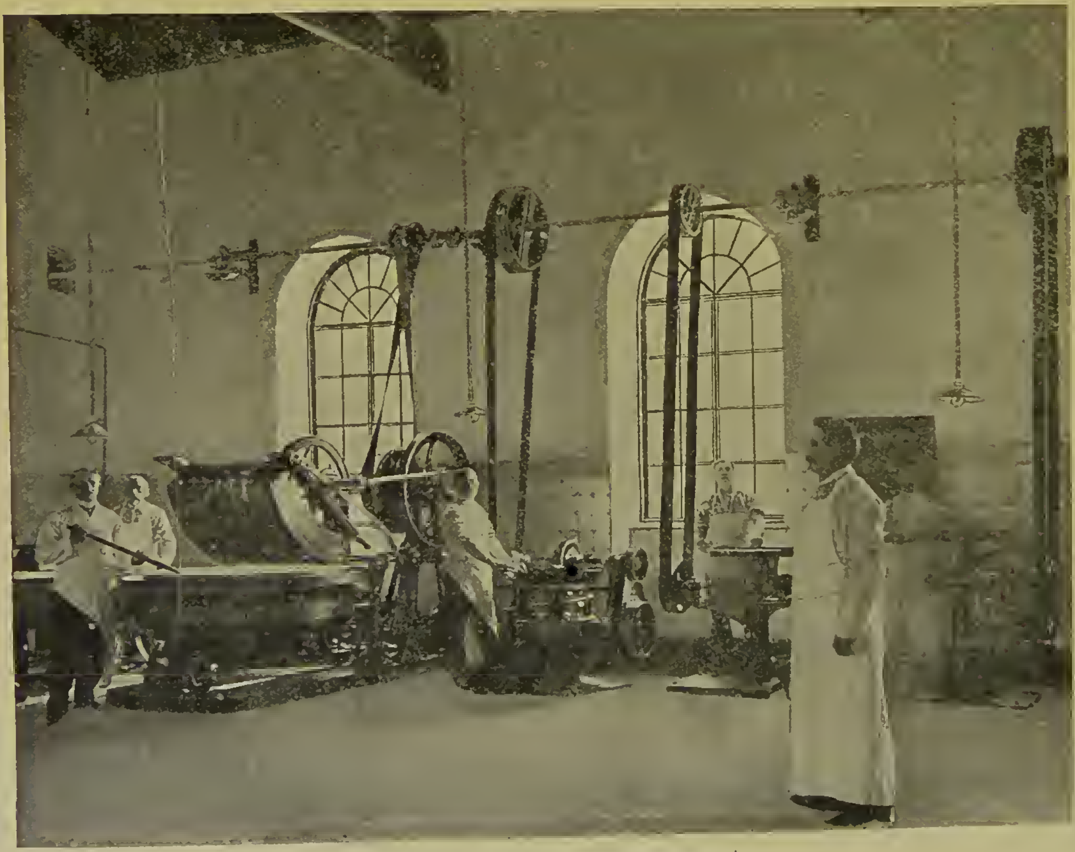


View showing Pigs hanging on Bars

The Cutting-off of Hams



The Smoke-ovens



Machines in Operation

CHAPTER VIII

REFRIGERATION

The preservative effect of a low temperature on meat and other perishable foods must have been known at a very early period, but the records of the knowledge of the ancients on the subject are very scanty. Where meat had to be stored up for future use, people, of course, learned to adapt their procedure to natural conditions.

For instance, meat and pork cannot be salted in hot weather so as to keep with certainty, and in quite early times the custom grew up of not killing beasts and pigs to be salted until the cold weather arrived. In the United Kingdom October was the favourite month, the temperature then running down to 40° Fahr. and under. In their crude, empirical way, our forefathers certainly discovered when ideal curing conditions prevailed, and in the most modern factories, where the temperature of the cooling-room is regulated by mechanical refrigerating machinery, the aim is to keep the figure at 38–40° Fahr. all the year round, *i.e.*, the temperature of the later weeks of October.

Stages in the Preservation of Meat. The further step of providing a room, cellar, or other enclosed space artificially cooled for the preservation of meat is a much more recent one. Even in Scotland, with its cool climate, and where ice may be had in abundance during most winters, the custom, in all the country districts at least, was to depend entirely in the winter months on autumn-cured meats. The idea that ice might be collected in the winter-time and kept until the hot weather came round, and then used in cold rooms to preserve the meat or assist in its cure, does not seem to have taken form till the beginning of the nineteenth century, and, indeed, the middle of the century had passed before much was done in that way.

The trade in ice as an organised business commenced in the United Kingdom about the year 1840, when the Wenham Lake Ice Company began to send supplies from America, and maintained them until it was found that Norwegian ice was equally good and within easier reach; the Norwegians, therefore, captured the whole trade, which they have held to the present day, when in turn their supremacy is being threatened by ice artificially made.

Growth of the Ice Industry. The natural ice trade has attained to colossal dimensions in the United States, where millions of tons are harvested every winter and stored in insulated houses, against summer requirements. Much thought and invention have been expended on the question of ice-handling by American engineers, and the tools and plant employed are eminently suited to the cutting, getting into store and out again, with the maximum of economy and speed.

Bacteria and Decomposition. The reason why low temperatures have a preservative effect on meat and other perishable articles was not understood until bacteriology had become a well-organised science. The germ theory supplies a complete explanation; it was shown that the decomposition, under ordinary natural conditions, of all kinds of animal and vegetable substances, was caused entirely by the action of various minute vegetable organisms called "bacteria," and that when these were absent, or prevented from growing and multiplying, decomposition did not take place. Bacteria are subject to the same laws which govern the growth and development of other vegetable organisms. We know that when the temperature of the atmosphere is under 40° Fahr., vegetation for the most part ceases to grow, and when bacteria are subjected to similar temperatures their development is also largely inhibited.

Open-air Christmas Meat Market in Russia

Natural Refrigeration in Cold Countries. A carcase which, in a warm, moist atmosphere would become unfit for food in forty-eight hours or less, will keep good for several weeks in a cold-room at 35–40° Fahr., and at lower temperatures—16–29° Fahr.—it will keep for years. The most striking instance on record of the preservative action of cold is that of the mammoth carcases found frozen up in the mud and peat on the edges of lakes and the margins of rivers in Siberia. The mammoth has been extinct for ages, but in the specimens found encased in ice, the ligaments, muscles, skin, wool, bristles, &c., were all present, and the meat was so fresh that it was eaten readily by wolves, dogs, and bears.

Natural refrigeration is made use of to a considerable extent in cold countries for the preservation of fresh meat. Our illustration shows the practice in some parts of Russia of storing large quantities of carcases of beasts, sheep, and pigs in the open air in the snow, until required for use.

An Ice-house in Hungary

Hungary is a country where mechanical refrigeration has not yet become general, and, as a consequence, the cooling effects are largely attained by natural ice, which is gathered from such lakes as Lake Balaton in the winter-time and stored up in low-walled, heavily thatched buildings, where it is kept over the summer, and the supplies for chilling meat and other perishable produce are derived from these ice-stores.

The settlers in the Canadian North-west frequently kill a beast in the beginning of winter and hang the carcase in an outhouse, where it keeps in good condition through the long winter, and pieces are cut off as required, generally with the aid of an axe. In this country Nature is more capricious, and no reliance can be placed on her winter favours. Some of the worst losses suffered by meat traders in the days before the cold-room had arrived, took place in the muggy days and nights which sometimes came before Christmas, when the stock of meat was, of course, abnormally large. In one instance, still remembered, the meat spoilt was valued at many thousands of pounds.

It has been clearly recognised for many years that artificial refrigeration is a necessary adjunct to the meat-purveyor's business, and, of course, the vast modern overseas trade in fresh meat could not be conducted without it.

COLD-ROOMS

The first apparatus for the preservation of meat in an atmosphere artificially chilled was the cold-room cooled by ice. Many thousands of these rooms are in use among the meat-purveyors in this and other countries, and the demand for them is still a very large one. Great improvements have naturally been made in their construction; the walls must be packed with a non-conducting material to prevent the passage of heat into the cold-room from the outside atmosphere and the consequent waste of ice. Sawdust was chiefly used at first, but it is surpassed in non-conducting power by several other materials which are now available, the chief of which are the following:

Silicate cotton, or mineral wool, made from blast-furnace slag by driving a current of high-pressure superheated steam from a fine nozzle across a stream of the molten material. A highly efficient non-conductor, easily handled and packed, and not subject to decay, is thus produced and used on a very large scale. Weight, 14 to 16 lb. per cube-foot.

Charcoal, from light woods, such as willow; a good deal used, but rather dirty to handle, and requiring hard packing. A very suitable charcoal is made in Scotland from the bobbin-turnings of the thread-works; of high non-conducting quality; weight per cubic foot, 10 to 14 lb.

Cork. Granulated cork refuse is a capital non-conductor. It only weighs from 4½ to 6 lb. per cube-foot, and is very useful where lightness is a consideration—as, for example, in refrigerated rolling-stock in railways, or where heavy carriages or freights have to be faced. Granulated cork is now frequently compressed into slabs for insulating purposes.

Cow-hair, cleaned with acid, washed and dried, is also a first-class non-conductor; it weighs about the same as cork and possesses similar advantages.

Cork and cow-hair, like sawdust, are subject to decay, especially if they are allowed to become damp. It will be seen that no one insulating material can be recommended for all purposes, but for cold-rooms and the insulation of cold storages silicate cotton has now undoubtedly got the lead.

The meat-purveyor's cold-room is sometimes made by lining a cellar, or other walled-in space, with insulating material cased in with woodwork, but more frequently it is an independent structure, having a skeleton of runners or battens of the thickness of the insulation, say, from 3 to 6 in. This skeleton is lined on each side with tongued and grooved matching, and the space between is packed with the insulating material.

It is very necessary that the insulation should be kept dry and free from any access of external air, and this is accomplished by placing under the matching on either side a layer of one of the numerous damp-proof sheetings made for the purpose.

Modern Method of Building Cold-rooms. The excellent practice now extensively prevails of building cold-rooms in six sections (ceiling, floor, sides and ends) in the factory, and fitting these sections together in the meat-purveyor's premises, thus saving annoyance to the purchaser and at the same time supplying him with an article that can readily be taken to pieces and removed elsewhere. The ceiling of the cold-room should be fitted with several automatic mica flap ventilators, which, by the expansion of the air inside the room, open and permit the escape of the steam and gases from hot meat newly put in, but which close automatically as the meat is chilled and prevent the escape of cold air.

The doors for the meat and ice should be separate, and each insulated like the rest of the room and made rabbeted or wedge-shaped to secure tightness, and made further airtight by india-rubber tubing or other packing. To force these thick, heavy doors home, they should be supplied with fasteners on the lever principle. As wood surfaces harbour bacteria and absorb taints, the room should be lined with sheet-zinc, which can readily be cleaned with a damp cloth. The cage containing the ice should be made of galvanised iron rod, and, as far as possible,

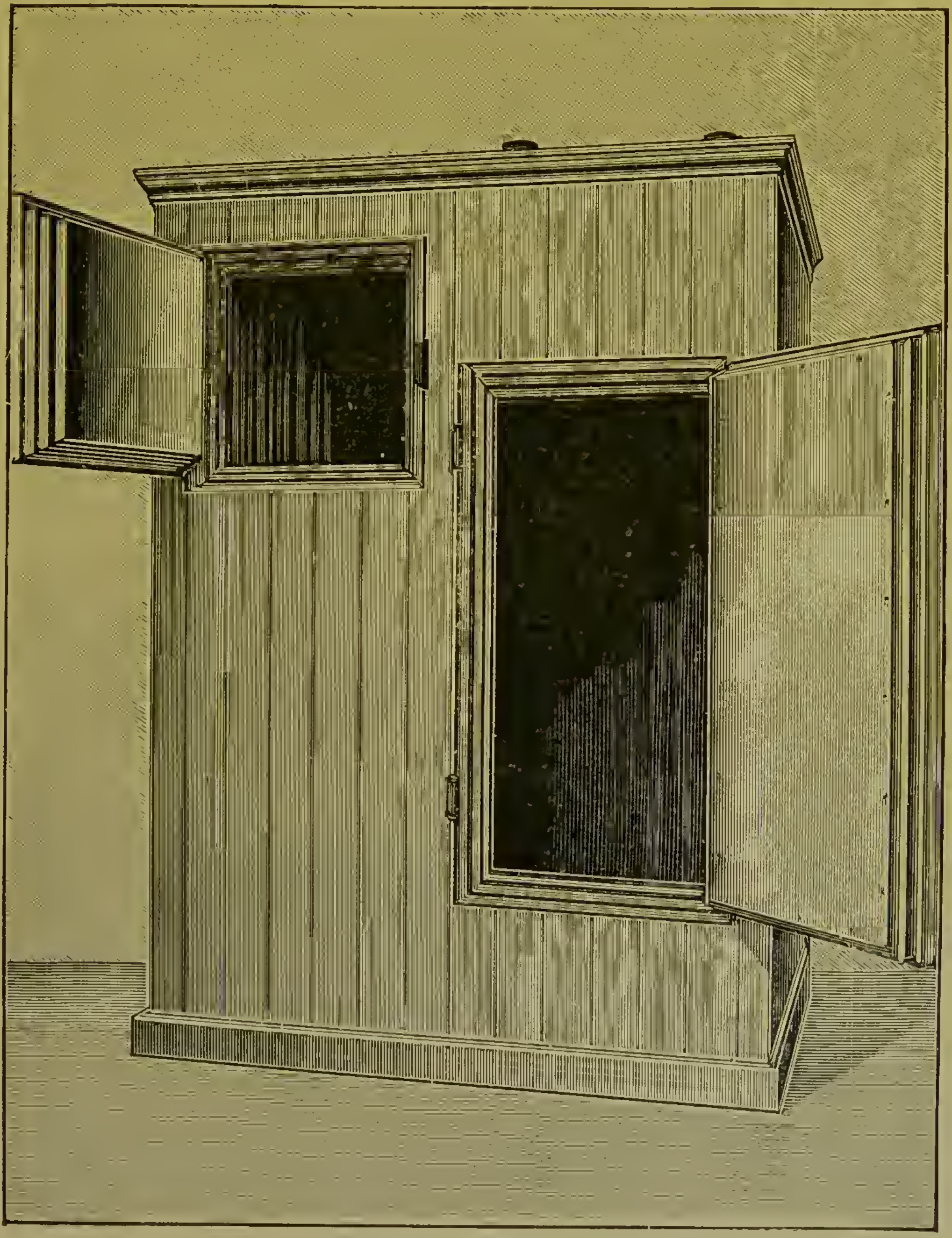


Fig. 1.—Meat-purveyor's Cold-room

everything inside the room should be of metal. The ice-cage in a properly proportioned cold-room, occupies one-sixth of the internal space, and is placed as near the ceiling as possible, because the air chilled by the ice increases in density and falls downwards, while the hotter air from the meat is lighter and goes upwards, and with ice at the ceiling it is at once chilled and sent downwards again. In this way a continual natural circulation is set up, until everything inside the room is of one temperature. If the cage were placed on the floor of the room there would be no circulation, the hot, impure air remaining at the top and the cold air at the bottom. Under the ice-cage is placed a zinc tray to receive the melted ice-water, and this tray ought to be insulated, as a plain metal tray is so chilled by the ice-water that moisture from the air of the room condenses on the under-side and falls on the floor—a contingency which must be avoided, as moisture on the floor penetrates to the insulation and spoils it for non-conducting purposes, and also keeps the interior of the room damp, which makes the meat "slimy." The tray is inclined to run the ice-water to the lower side, from which a trapped pipe takes it through the wall of the chamber to a pail or drain.

Fig. 1 is an illustration of a meat-purveyor's cold-room, constructed on these lines.

The meat and ice doors are shown in the front, but the latter may be fixed in either end or in the ceiling. Sometimes these rooms are placed in cellars with a trap-door entrance from the shop above. This is a good arrangement, as every time the meat-door on the front is opened, there is a considerable escape of the heavy, cold air, which simply falls out and is replaced by the lighter and warmer outside air, leading to increased consumption of ice. The average temperature in a room cooled with ice alone is 40–44° Fahr. If lower temperatures are desired, a mixture of broken ice with about 10 per cent. of common salt must be used, and a tank to hold it substituted for the network ice-cage. In this way temperatures down to the freezing-point can readily be obtained, the consumption of ice, of course, going up in proportion.

In these cold chambers the ice receptacle should be kept as full as possible, and the oftener it is filled up the better, the full charge of ice being necessary to give the best results. This does not lead to a greater consumption of ice, but rather the contrary.

How to Manage Cold Chambers. One cardinal point in the management of cold chambers is to open them as seldom as possible, otherwise there is a great loss of cooling effect and dampness is apt to be produced, because the outside air thus freely introduced contains, as a rule, more moisture than it can hold at a low temperature, and deposits it when chilled, inside the chamber. The man who uses his cold-room as a kind of handy store to run into all day long, cannot expect good results. In a properly constructed and carefully worked cold chamber a box of ordinary matches can be left for a week, and will then light freely by rubbing on the inside lining.

The cold chambers described, as has already been hinted, require to have their ice charges continually renewed, say, on the average, twice a week. A different plan is pursued where refrigeration by ice on a large scale is made use of, as, for example, in the Danish and Swedish bacon factories. The curing-cellars consist of two rooms of equal size, one being the cellar proper and the other filled with ice. The two are connected by numerous ports to allow the hot air to pass to the ice to be chilled, and to return to the cellar after chilling. The temperature can be regulated by having adjustable slides in these ports, so that the flow of air can be increased or diminished at will.

Fig. 2 shows the section of such a curing-cellar. Ice is, of course,

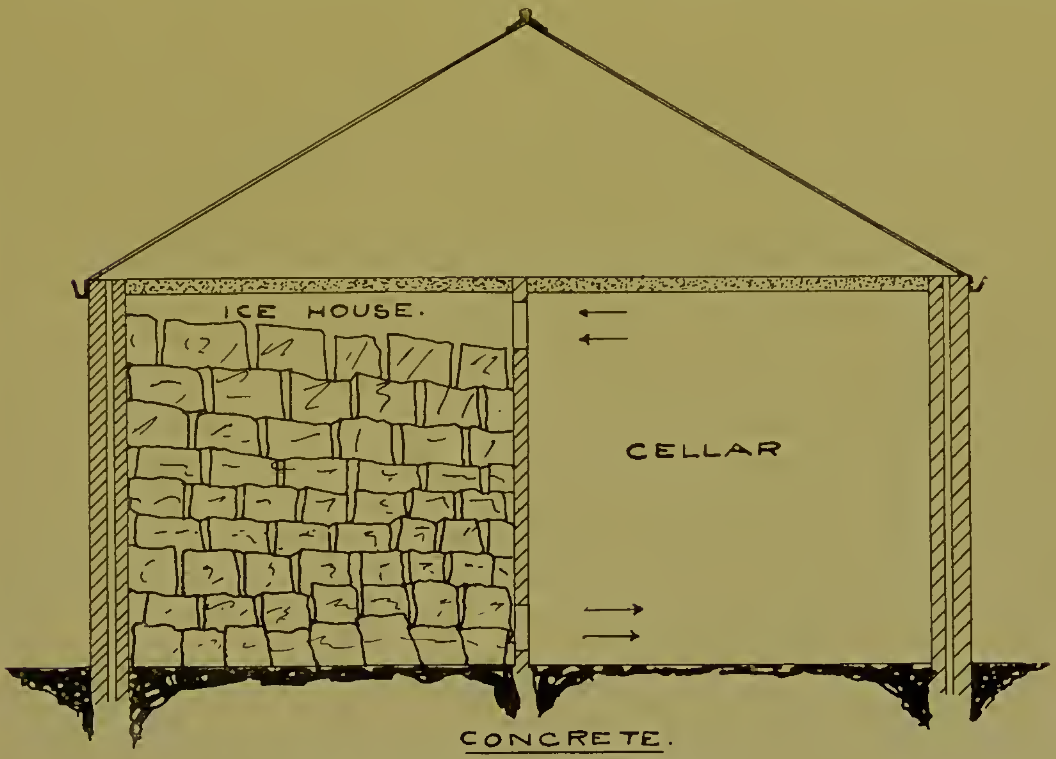


Fig. 2.—Danish Curing-cellar

very abundant in Denmark and Sweden, and large heaps of it are put up in the yards of the bacon factories and covered over with a layer of sawdust, and from these heaps the stock in the room alongside the cellar is renewed from time to time.

In the English and Irish bacon factories the cellars at one time were made very high, and the upper half was occupied by a huge iron tray supported by columns, and this tray was piled up with many tons of ice.

Similar plant for meat handling is used in the north of the United States and Canada, but the development of the refrigerating machine is rapidly making the method an obsolete one.

Mechanical Refrigeration. Mechanical refrigeration and ice-making have not a very lengthy history. The great strides made by chemistry and physics in the beginning of last century, and the demand for natural ice which arose in the 'thirties and 'forties, led to attempts to produce ice, or cooling effects, artificially.

The liquefaction of gases by Faraday and Lavoisier afforded the basis for experiments, and as early as 1834 we find an English patent taken out by Joseph Perkins in which all the principles of the modern compression-machine are embodied. In France, in the 'fifties, Carré worked at refrigeration first with ether, and then he produced his famous ammonia machine, a form of which is still used in laboratory demonstrations.

Harrison, of Australia, and Professor Twining, of Ohio, were in the field about the same time, and both produced ice on a commercial scale in 1855. From 1860 to 1870 was a great time in the history of refrigeration; with an eye to the overseas transport of meat, Mort and Nicolle, in Australia, invented and experimented largely with refrigerating machinery, and although they did not attain to commercial success, they certainly laid the foundation of the frozen-meat industry. It was reserved for Bell and Coleman, of Glasgow, to make the business practicable. In 1879 they installed a cold-air refrigerating-machine on board the *Strathleven*, and with it brought, in good condition, the first cargo of frozen meat from Australia to London. Since then the development of the refrigerating-machine has gone ahead by leaps and bounds. The Bell-Coleman machine is now obsolete, and much more efficient machines have taken its place. It is, however, beyond the scope of this work to trace the course of invention in connection with refrigerating machinery in detail; suffice it to say that we have now the choice of many excellent competing machines for all purposes, even the wants of the small caterer being now efficiently provided for.

The Compression Machine in Refrigeration. By far the greater part of the world's refrigerating work is performed by the compression-machine, and we will describe it first in connection with the theory of refrigeration. By way of clearing the ground, we will first mention some facts which have a bearing on the matter. If you place in the palm of your hand a few drops of ether or other volatile liquid, the latter evaporates off quickly and a sensation of cold is produced; heat has been withdrawn from the hand to turn the volatile liquid into a vapour. When a piece of ice is put into a vessel with a thermometer, and heat applied, we find that the ice melts, but the temperature does not rise above 32° Fahr. as long as any ice remains. When the ice is all melted the temperature rises until the boiling-point is reached, when the mercury again stops and remains at 212° Fahr., under average atmospheric pressure, until all the water has been turned into vapour.

What is the reason of the two different pauses in the upward mounting of mercury? Obviously heat is being absorbed all the time. What becomes of those portions which have no sensible effect on the thermometer? The old idea was that the heat so absorbed had been "fixed" or become "latent," and we still call it "latent heat." The term affords no explanation of what takes place, and to find this we must appeal to the first laws of thermo-dynamics; in other words, to Joule's mechanical equivalent of heat, which states that heat may be converted into motion, and that a certain amount of heat is equivalent to a certain amount of motion. To state the ratio, it may be said that the amount of heat required to raise the temperature of one pound of water 1° Fahr. is equal in mechanical effect to the raising of 1 lb. 778 ft. or 778 lb. 1 ft. Let us see the bearing of this on heat applied to ice and water. According to the atomic theory all matter is made up of extremely minute particles, called "molecules." These, in the case of solids, are bound together almost, but not quite, immovably by the force of cohesion. When we apply heat to a solid such as ice, the heat is turned into the energy required to overcome the force of cohesion—to push the molecules further apart—and the effect is that the solid is changed into a liquid, in which the molecules move freely round one another and the liquid readily moulds itself so as to fill any space. With ice at 32° Fahr. the conversion of the heat applied into the above form of energy is complete, and therefore no rise in the thermometer takes place till the ice is all melted. When we get to the boiling-point of water the force of the cohesion is entirely overcome, and the molecules fly apart with violence. With standard atmospheric pressure and a free escape for the vapour formed, we have here again a total conversion of the heat absorbed into energy, and the thermometer stands at 212° Fahr. while any water remains. We are now in a position to see how these facts are applied in mechanical refrigeration. The compression machine consists of four elements, as illustrated diagrammatically in Fig. 3.

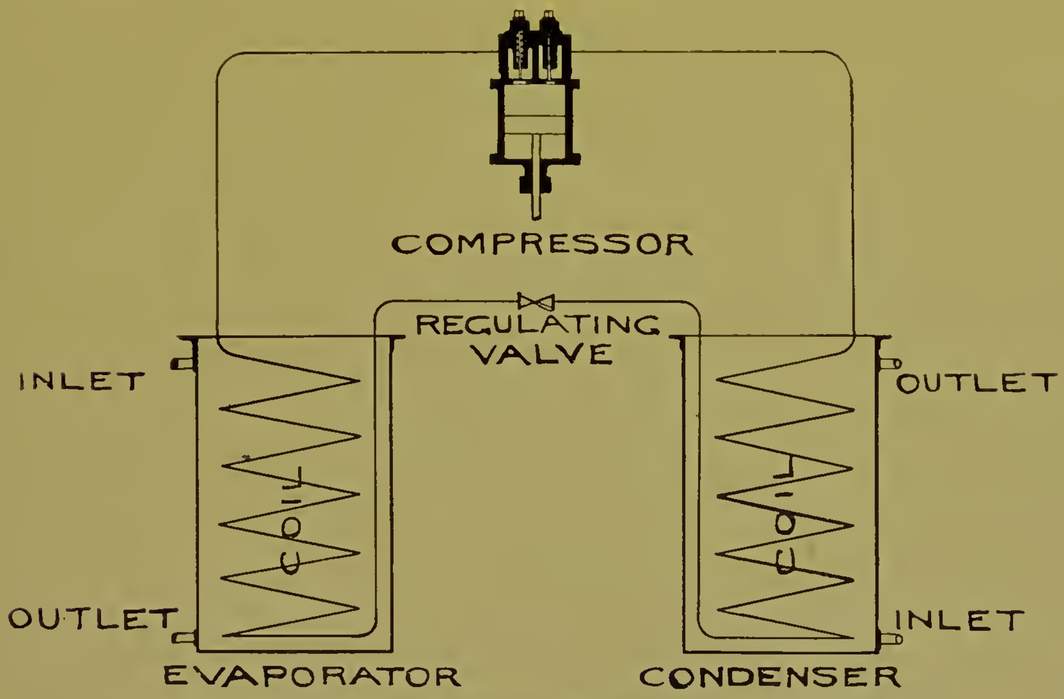


FIG. 3.—DIAGRAM OF COMPRESSION REFRIGERATING-MACHINE

(1) A coil of pipe, in which the refrigerating medium is evaporated.

(2) A pump, or compressor, which draws off the vapour from the evaporating coil on the one side and on the other compresses the vapour into (3) the condensing coil, where by the aid of cold water the vapour is again turned into liquid form.

(4) A pipe connecting the ends of the coils opposite to those connected to the pump, to one another, and on this pipe is a valve for regulating the flow of the liquid refrigerant, so that it is supplied as fast and no faster than it can be volatilised in the evaporator-coil.

We have, then, on the one side the evaporator-coil in which by the aid of the pump or compressor the liquid refrigerant is rapidly turned into vapour and drawing the heat necessary for this change first from itself and then from its surroundings, which may be the air of a cold-room or, more commonly, a tank of unfreezable brine.

The brine is cooled to a very low temperature, and in this state may be circulated by a pump through suitable pipes, brine-drums, &c., where the cooling effect is wanted; in cold-rooms, ice-making tanks, &c., returning in each case continuously to the evaporator-tank to be cooled afresh. Let us now look at the other side of the system connected with the compression part of the pump or compressor. The force supplied by the latter, together with the effect of a current of cold water applied to the outside of the condenser-coil, reverses what has taken place in the evaporator-coil. The vapour is compressed, and the energy which maintained it as a vapour is again turned into heat, which is carried off by the cooling water, and gradually the vapour is reconverted into a

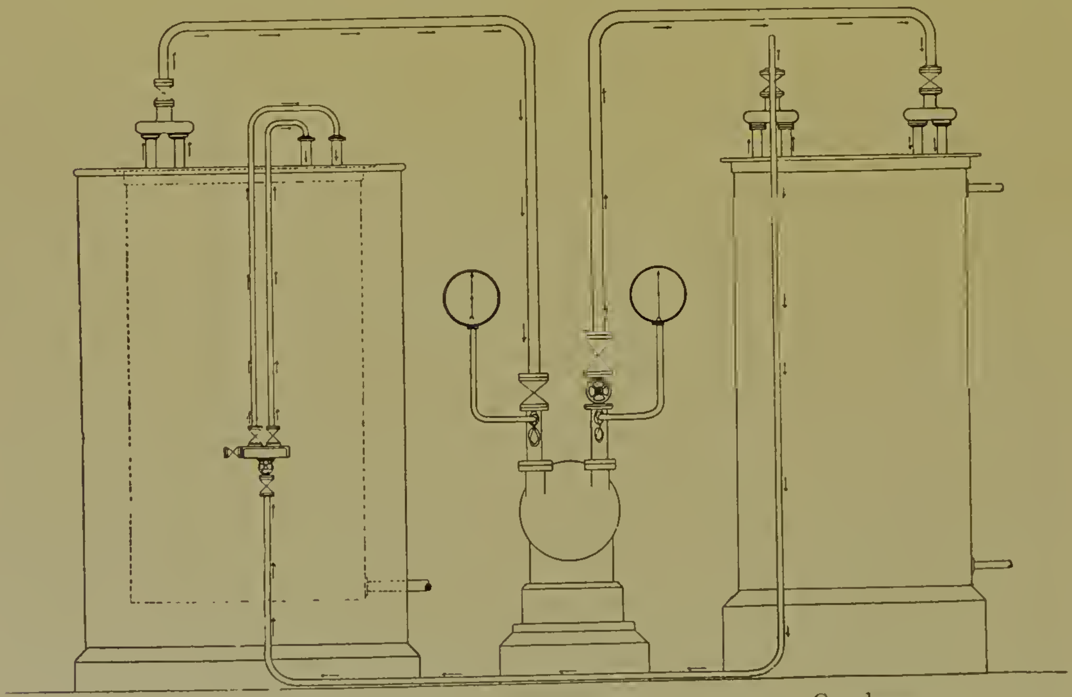


Fig. 4.—Diagram showing the Construction of a Modern Refrigeration Machine on the Compression Principle

liquid, which is admitted at the proper rate through the regulating valve into the evaporator-coil. And so the process goes on continuously as long as the machine is running.

Fig. 4 illustrates in a partially diagrammatic form the components of a compression-machine of a common type, with the evaporator-tank on the left filled with calcium-chloride brine surrounding the coils (in this case double, the one inside of the other). On the right is the condenser-tank, through which a current of cold water flows to cool the condenser-coils (also double). In the middle is the pump, or compressor, with the "suction" gauge on the evaporator side and the "pressure" gauge on the condenser side, the readings of which are of great importance in the proper setting of the regulator-valve. The latter is shown on the side of the evaporator, being connected to the two coils by a "header." Other three headers are placed on the ends of the evaporator- and condenser-coils, and stop-cocks are distributed on the connecting-pipes to permit of any part of the system being shut off from any other part when necessary.

The compression refrigerating-machine is exactly the opposite in most respects to the steam-engine. The latter drives itself, the former is driven. Steam enters the cylinder of the engine at high temperature and pressure, has part of its heat converted into mechanical motion, and leaves at a lower temperature and pressure. In the compressor the vapour is drawn into the cylinder at a low temperature, and leaves it at a higher temperature. In the steam-boiler, heat is applied to change water into vapour highly charged with energy, and this energy is partly given up in the engine, while, in the compressor, we apply energy to evaporate the refrigerant liquid and draw the heat required for the purpose, from itself and its surroundings.

The refrigerants commonly used are: liquefied anhydrous ammonia (NH_3), carbonic anhydride (CO_2) and sulphurous anhydride (SO_2), and, less frequently, ordinary ether, methyl chloride, ethyl chloride, air and water. Ether machines are still used to some extent in tropical climates, methyl chloride has been adopted by one maker in France, ethyl chloride has only been used experimentally; cold-air machines are largely out of date, and the water-vapour process is now mostly adopted for small domestic machines. We will confine our attention to the first three refrigerants named:

Anhydrous ammonia is obtained by heating ammonia-salts with lime. It is a colourless, extremely pungent gas at ordinary temperatures and pressures.

Carbonic anhydride is given off in the breath of animals, in the waste gases from fires, and the fermentation of sugar or malt in breweries and distilleries, and in the general decay of organic matter. For refrigerating purposes a certain amount is now obtained from breweries, but the greater proportion of the supply comes from the gases given off in the burning of coke. These gases are passed over washing-soda, which absorbs the carbonic anhydride and gives it off in the pure state by subsequent heating.

Carbonic anhydride is a heavy, colourless and odourless gas at ordinary temperatures and pressures.

Sulphurous anhydride is made by burning sulphur and passing the gases produced over lime, which absorbs the sulphurous anhydride. The resulting calcium sulphite is decomposed by sulphuric acid, and sulphurous anhydride is evolved in a concentrated state and is dried by bringing it in contact with strong vitriol. It is a clear, colourless gas under ordinary conditions, with the pungent smell of burning sulphur.

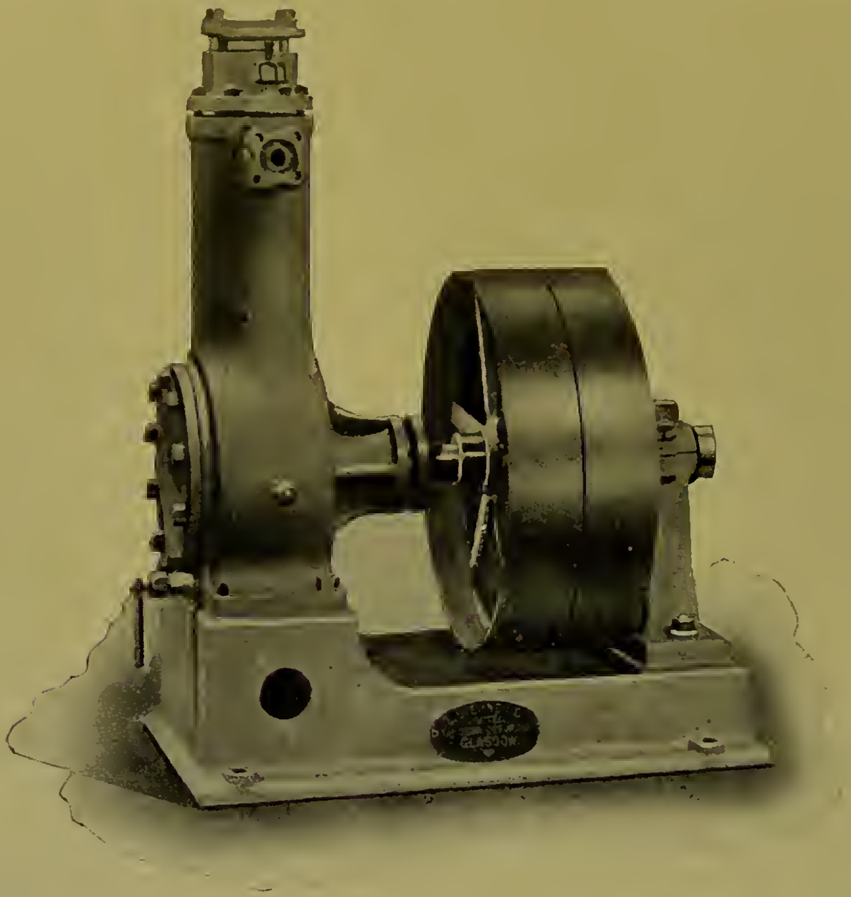


FIG. 5.—VERTICAL ENCLOSED MACHINE, BELT-DRIVEN, SMALL SIZE (STERNE)

For the purposes of refrigeration these gases are first converted into liquids by the application of pressure and cooling water, and they are then packed into strong steel cylinders, with special valves for use. The pressures required for liquefaction are very different in each case, and taking the cooling water at 59° Fahr. they are as follows:

Carbonic anhydride	768 lb. absolute.
Anhydrous ammonia	106 ,,
Sulphurous anhydride	40 ,,

These figures may also be taken as the average working pressures on the condenser side of the refrigerating-machines. The liquids are all, of

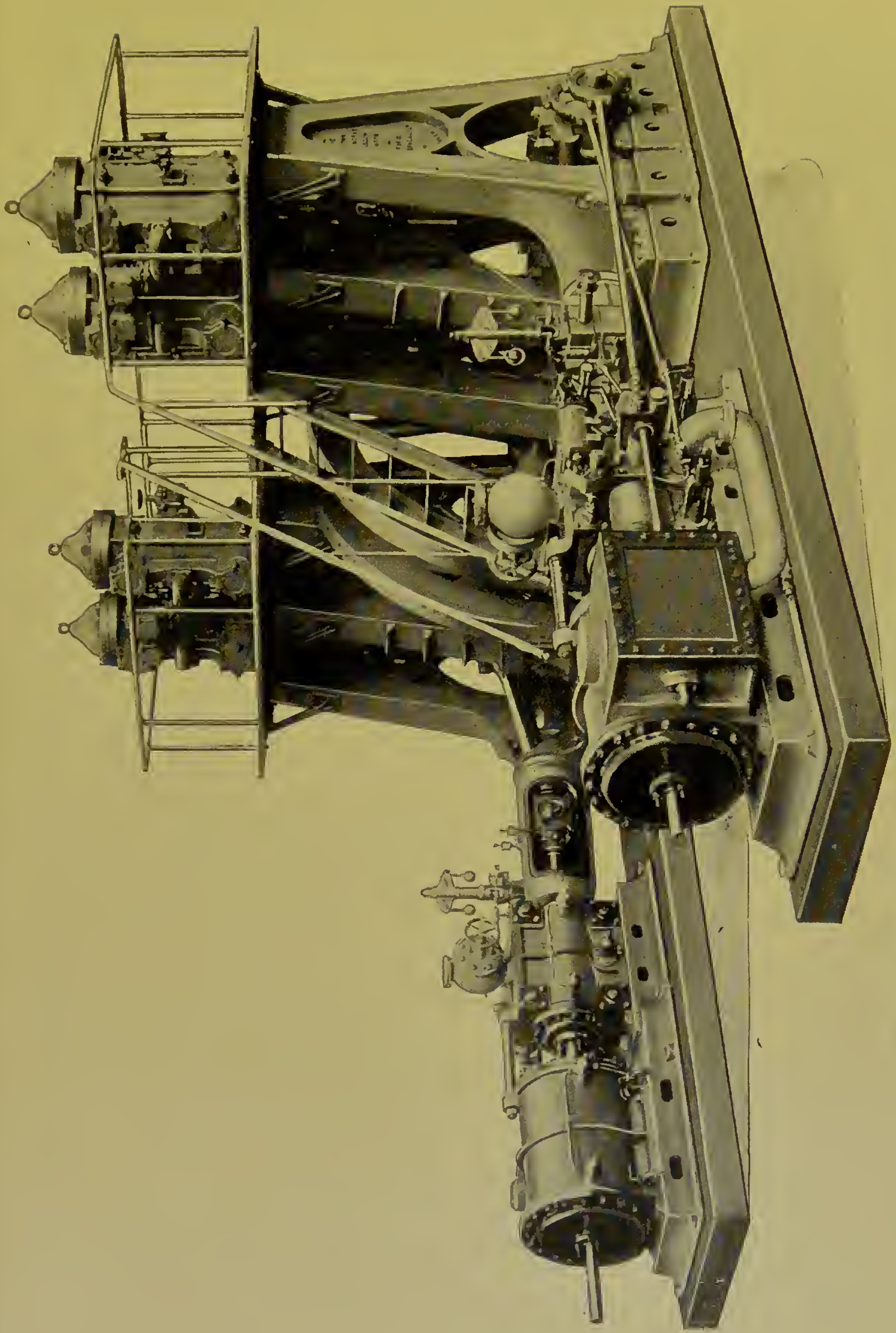


Fig. 6.—Vertical Machine (Two Units), Steam-driven, Large Machine (Sterne)

course, extremely volatile, and when allowed to evaporate freely, convert heat into the mechanical energy required to transform them into vapours at a very rapid rate, and are therefore most powerful refrigerants. Ammonia has the greatest vogue as a refrigerant ; carbonic anhydride comes next, and sulphurous anhydride has not made the same headway as the others, although it is now coming more into use, and the largest public abattoir in the world—that of Berlin—has its cold-storage plant operated by sulphurous anhydride machines.

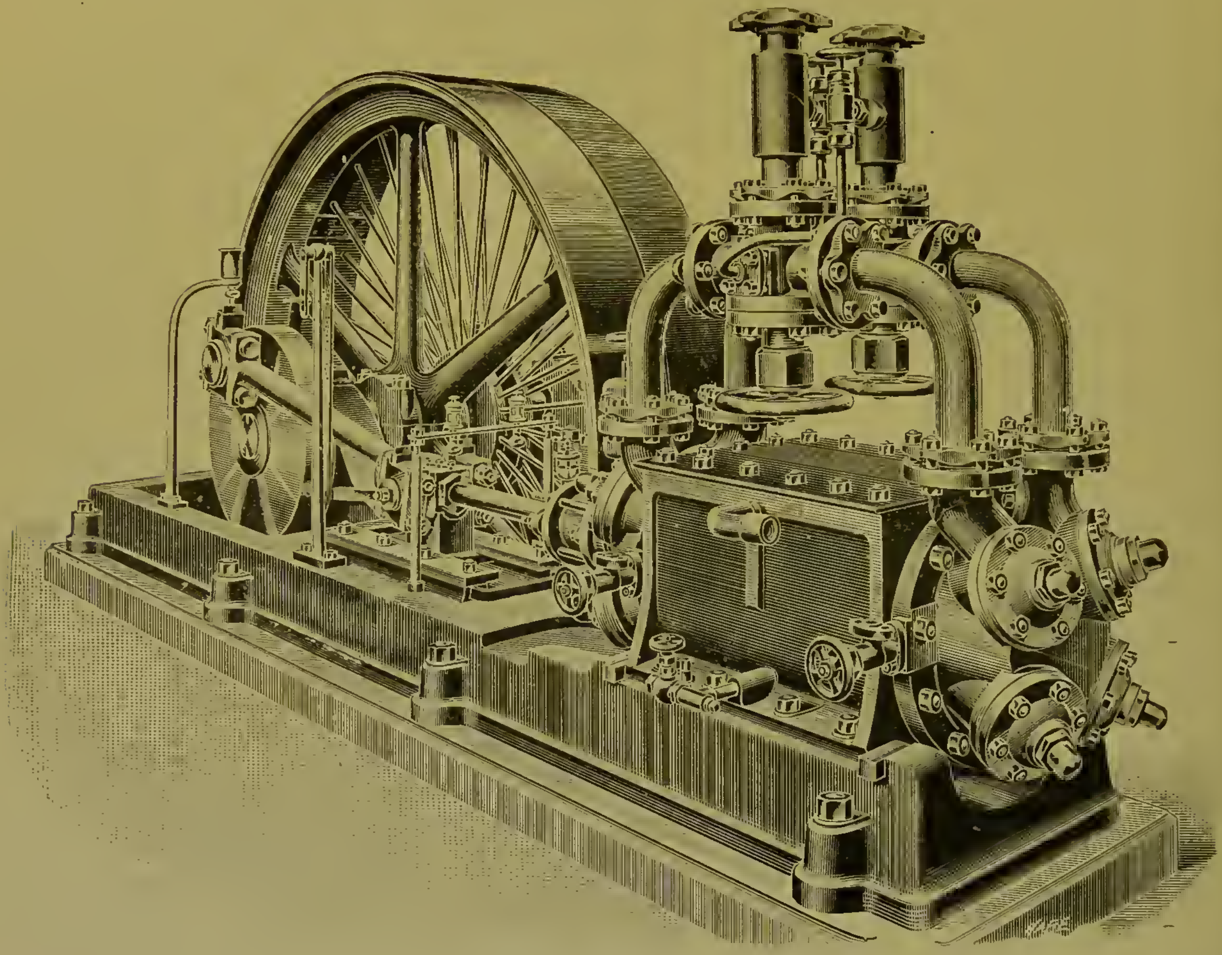


Fig. 7.—Horizontal Machine, Belt-driven, Large Size (Haslam)

Different Types of Machine. The quantity of vapour to be evaporated for a given amount of refrigeration varies roughly in inverse proportion to the condensing pressures, and a different design of machine is required for the handling of each refrigerant. The carbonic anhydride compressor must have a relatively small and narrow compressing cylinder, special arrangements in the way of valves, joints, packing, lubrication, and very high-class material to enable it to compress safely and without leakage ; and a small amount of refrigerant at a very high potential. Carbonic anhydride is non-corrosive, and any suitable metal can be used in the construction of the compressor.

The ammonia machine has to pump a medium quantity of vapour, and the size of its cylinder approximates to that of a simple steam-engine, powerful enough to drive it and using high-pressure steam. Ammonia corrodes copper, brass and gun-metal, and only steel and iron must be brought in contact with it.

The sulphurous anhydride machine requires a large cylinder to handle the greater amount of vapour which must be pumped, but the pressure being very low, this cylinder is easily driven.

Both carbonic anhydride and ammonia machines require oil-separators, to free the gas being condensed from lubricating oil picked up in the cylinder. Liquid sulphurous anhydride is an excellent lubricant itself, and no oil is needed in the compressing cylinder, and consequently no oil-separator. It is, therefore, a simpler machine, and when pure and free from air and moisture, sulphurous anhydride is absolutely non-corrosive, and all ordinary metals can be used in the construction of the compressor. Care must be taken to exclude air and moisture as much as possible, but the low-working pressure makes this an easy task.

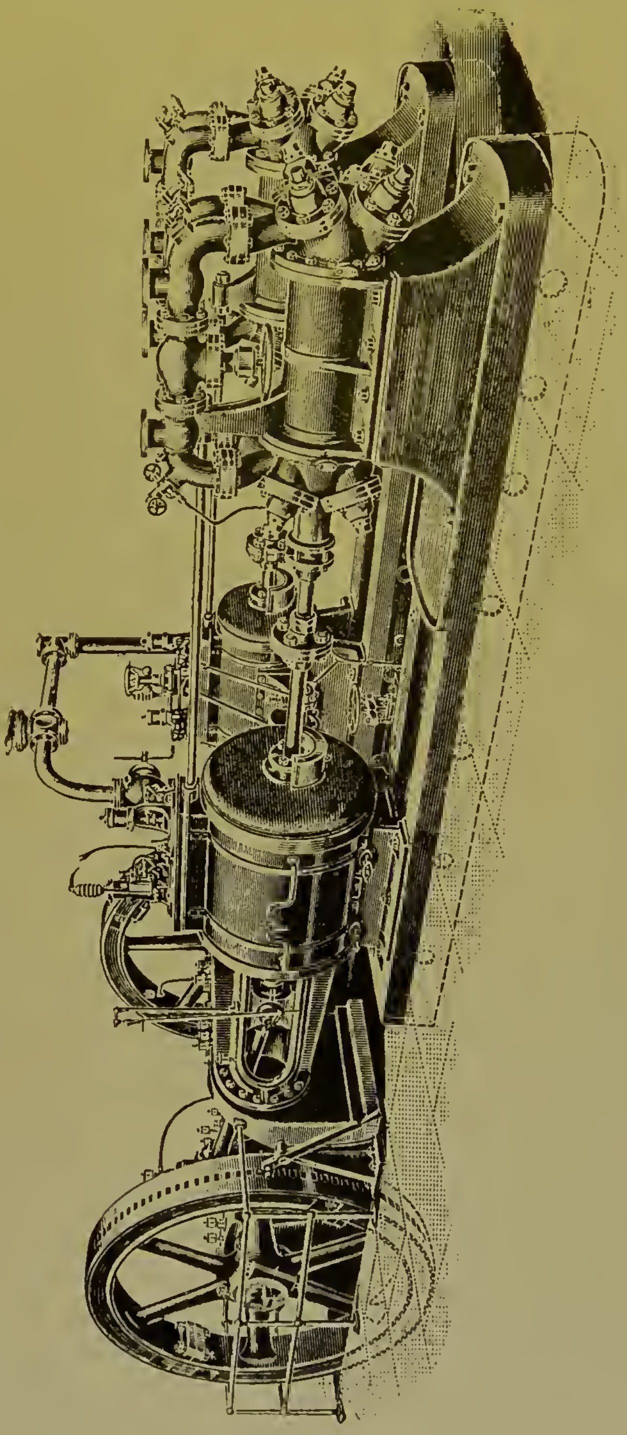


Fig. 8.—Horizontal Machine, Steam-driven. Large Size (Haslam)

Which is the most suitable Refrigerant? Much argument has been expended on the question of which is the most suitable refrigerant. Naturally every maker of refrigerating machinery claims that the one he uses is the best. The truth seems to be that there is no "best" refrigerant; one may have advantages in certain special circumstances over the others, but all have numerous good points and may be bracketed together as approximately equal. The question of the power required to effect a given amount of refrigeration is an important one, but here again the most reliable experiments give practical equality. The correct designing and proportioning of a refrigerating-plant is of much greater importance for producing economy in working than any differences in the qualities of the refrigerants.

There are other systems of refrigeration besides that associated with the compression-machine, but they are all founded on the same basic principle of the conversion of heat into the energy required to transform a volatile liquid into a vapour. There is, for instance, the absorption system, in which we start with strong liquid ammonia, which is distilled from a boiler, and the anhydrous ammonia given off is condensed, by its own pressure and the aid of cooling water, to a liquid, which is evaporated in coils as in the compression-machine but without the intervention of the compressor, and the vapour is absorbed again in water to form liquid ammonia, which is pumped into the boiler, and the cycle begins over again. The only difference is that we pump ammonia solution instead of anhydrous ammonia gas, and we introduce water as a solvent which, by its powerful affinity for anhydrous ammonia, pulls over the gas and takes the place of the suction side of the compressor. In the out-of-date cold-air machine we begin by compressing air and bringing the molecules closer together, thus converting into sensible heat a portion of the energy required to keep the molecules apart. This heat being taken away in cooling water, the compressed air is allowed to expand, and at once takes in heat from its surroundings and converts it into the energy required to separate the molecules of air to their original distance from one another.

Evaporative Process of Ice-making. Then there is the evaporative process of ice-making, in which a portion of the water to be frozen is rapidly evaporated by the aid of a pump, assisted by strong sulphuric acid as an absorbent for the water-vapour, and ice is very quickly made in this way, but unfortunately it is "rotten," or in other words, opaque and soft, and not of much value as a merchantable article.

The further comprehension of modern refrigerating machinery and its parts, and the means for transferring the cooling effect to where it is wanted, will best be facilitated by an examination of the designs of some of the leading makers, whose own illustrations we have in all cases (by permission) reproduced.

Ammonia Machine. Beginning with the ammonia machine, Fig. 5 shows a small vertical enclosed compressor, belt-driven; it is single-acting, having one suction and one compression valve on the top of the cylinder. The crank and piston-rod are enclosed in a chamber which is partly filled with oil, securing perfect lubrication. A very simple and silent-running machine.

Fig. 6 shows a large vertical plant of two units, with two double-acting cylinders each. The whole is driven direct by compound horizontal steam cylinders. This plant is capable of making sixty tons of ice in twenty-four hours.

In Fig. 7 we have a large horizontal belt-driven compressor, double-acting, with two suction and two compression valves at each end, or eight altogether. The pairs of valves are connected by cross-over pipes, so that one pipe supplies all the suction-valves and another single pipe takes all the compressed gas.

A two-unit horizontal plant direct-driven by a compound steam-engine is shown in Fig. 8; each cylinder has eight valves. Rated to make seventy tons of ice per twenty-four hours.

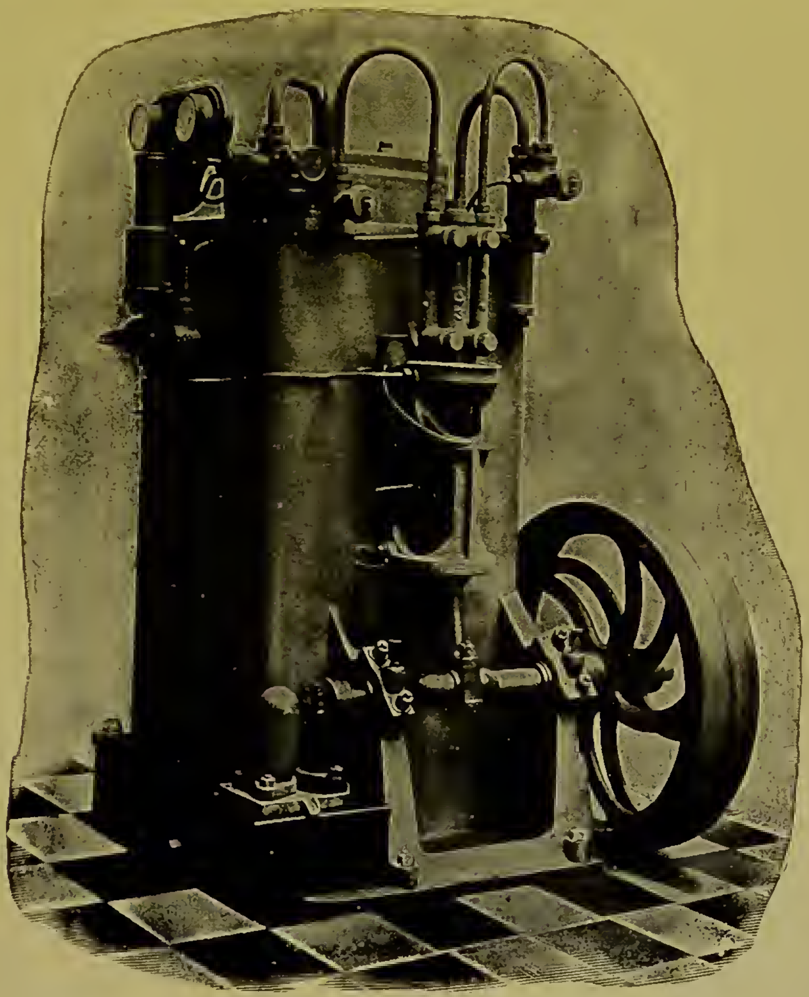


Fig. 9.—Vertical Machine, Belt-driven, with Condenser and Evaporator, Small Size (Hall)

Carbonic Anhydride Machine. In Fig. 9 we have another small belt-driven compressor, complete with square cast-iron condenser and circular evaporator placed inside. On the right-hand corner at the top is the oil-separator and patent safety disc. On the left is the lubricating-oil pump for forced lubrication, and low down is the brine-circulating pump, driven from the end of the crank-shaft.

A large steam-driven machine of the marine type is shown in Fig. 10.

The box foundation underneath is used as the condenser, thus saving space—so valuable on ship board.

Sulphurous Anhydride Machine. Fig. 11 is a horizontal belt-driven, double-acting machine, with water-jacket in the cylinder and the usual cross-over pipes.

Modern Ammonia Absorption Machine. The absorption machine went out of favour for some time, but recent improvements have again brought it into line with the compression machines. Fig. 12 shows the

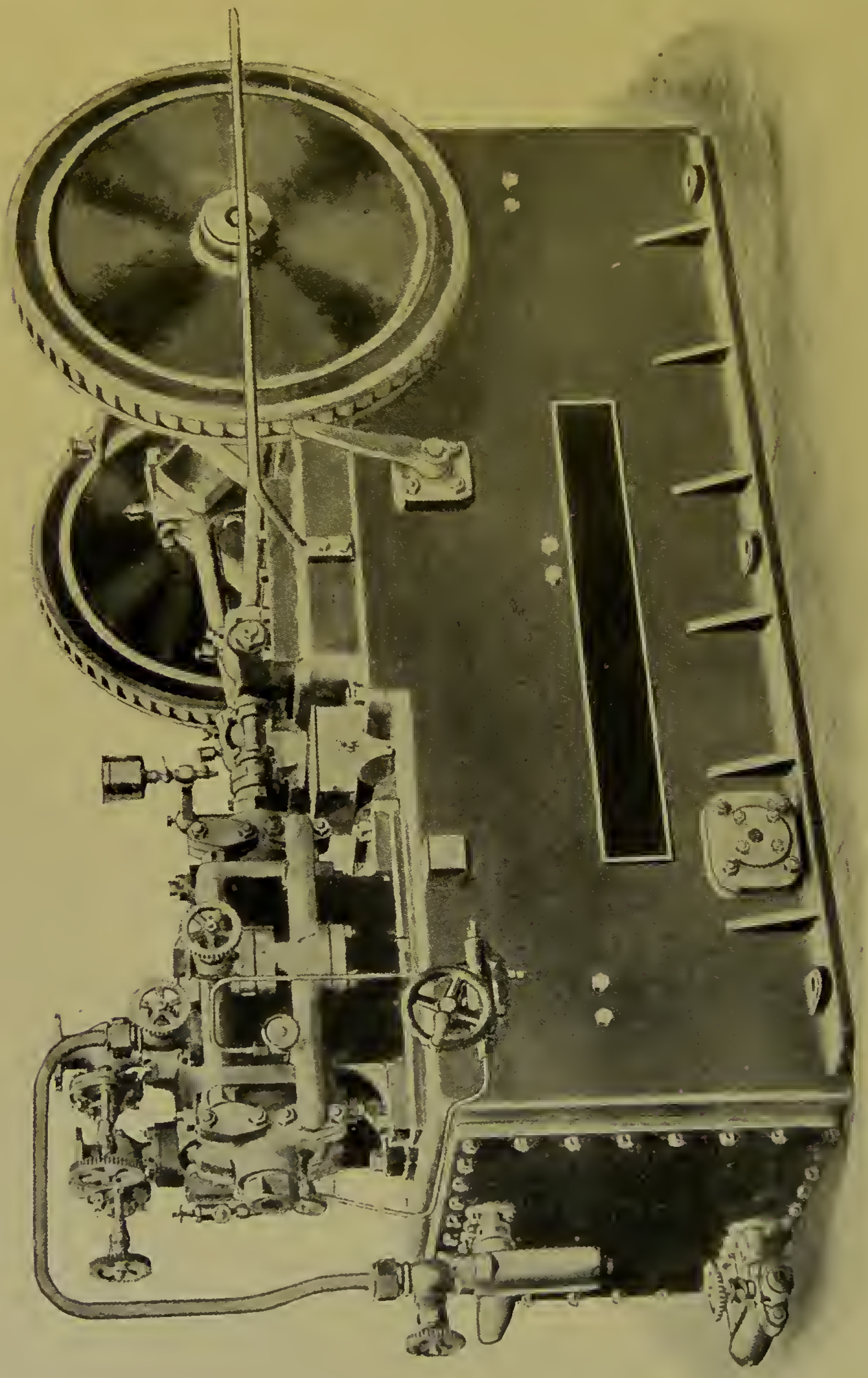


Fig. 10.—Marine Type Machine, Steam-driven, Medium Size (Liverpool Refrigeration Co.)

most recent absorption plant for installations of small and medium sizes. It consists of a series of cylinders with pipe-coils inside, and the arrangement of these coils has now been much improved. The cylinders consist of an absorber in which the evaporated gas is dissolved in cold water; a boiler where the liquid ammonia so produced is heated by steam and parts with its ammonia; rectifiers, where the water-vapour which accompanies the boiled-off gas is condensed by a stream of the cold liquid ammonia on its way to the boiler; and a condenser, where the dried gas is liquefied by its own pressure by the aid of cooling water. The liquid anhydrous ammonia then passes on to the evaporator-coils, and is evaporated with the assistance of the vacuum caused by the absorption of the gas in the water contained in the absorber, to which the exit ends of the evaporator-coils are connected. It is necessary to pump the liquid ammonia from the absorber into the boiler, and a very perfect slow-acting pump has been devised for this purpose which has greatly improved the working of the plant.

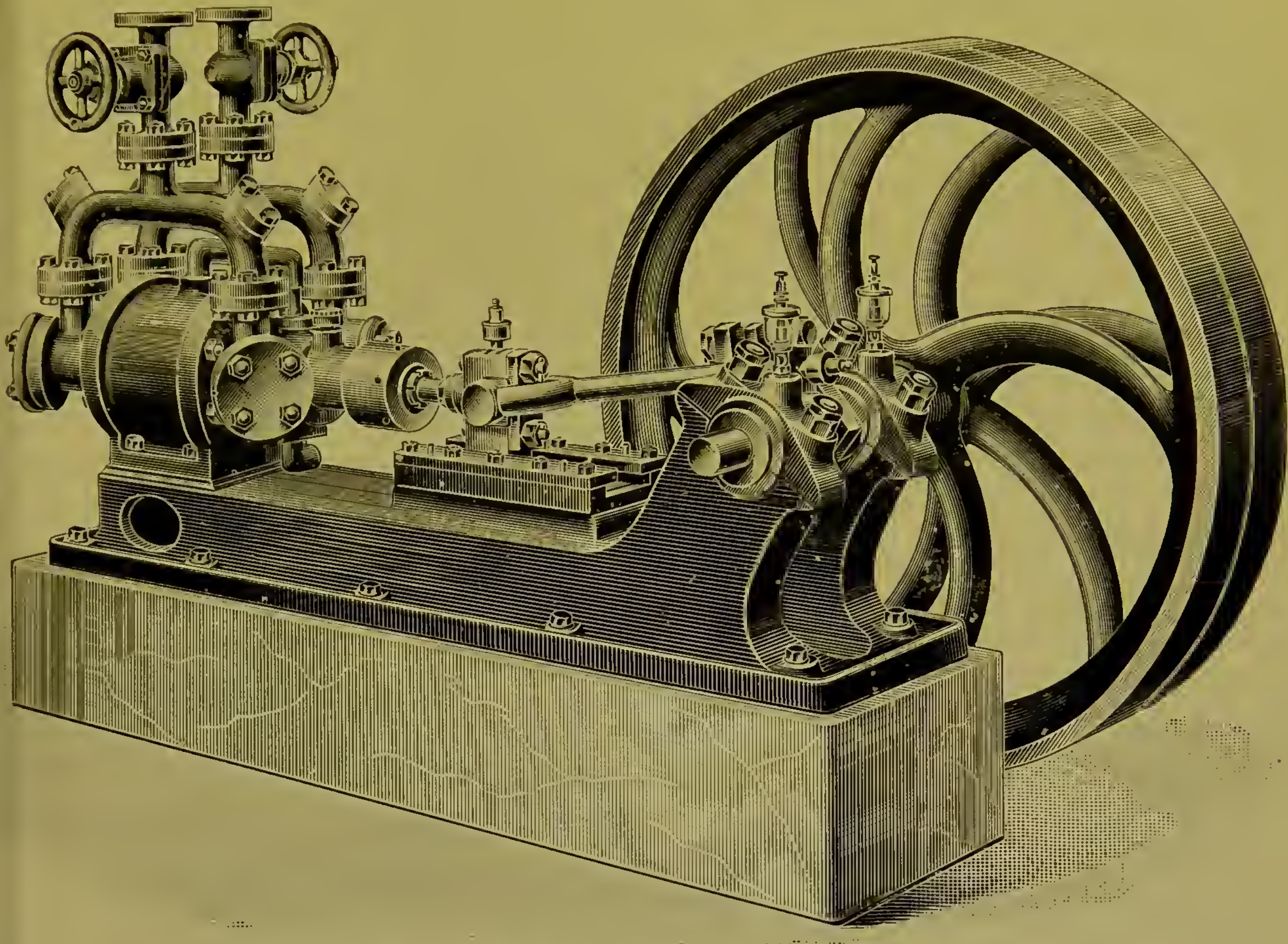


Fig. 11.—Horizontal Machine, Belt-driven, Medium Size (Douglas)

The Compression Machine and its Component Parts. To return to the compression-machine, we have exhibited a representative selection

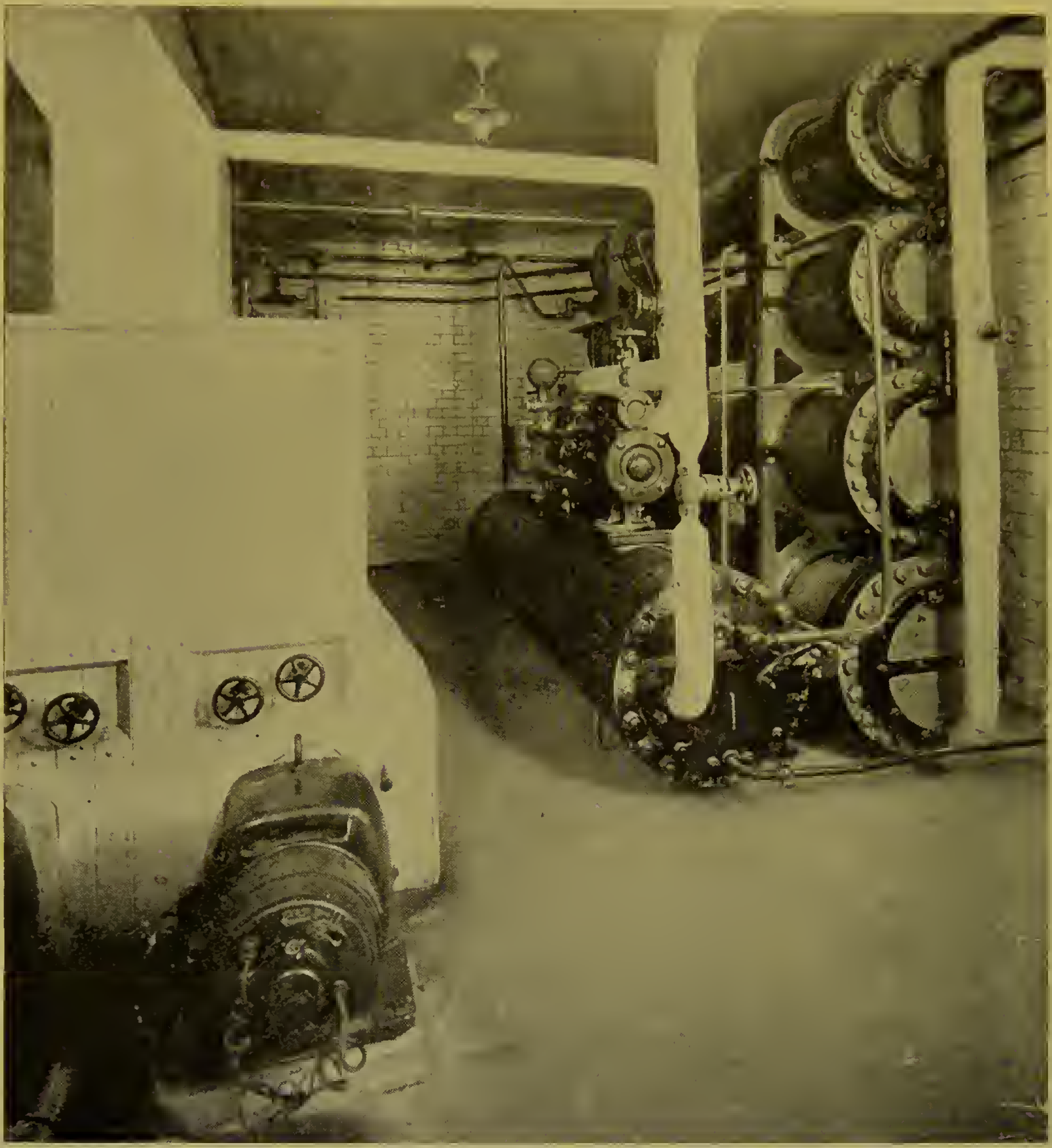


Fig. 12.—Absorption Refrigerating-plant (Ransomes and Rapiers)

of modern compressors, and will now proceed to deal with the other elements of the system—the condensers, evaporators, &c.

These do not present the same diversity of design as the compressors, and with slight modification the same apparatus can be used in connection with machines using any refrigerant. In small installations, as we have already seen, the whole plant is frequently combined on one bed-plate, and in the marine machine the condenser is usually combined with the foundation casting, but in the majority of large plants the condenser and evaporator are separate from the compressor. In Fig. 13 we show a two-coil brine-cooling evaporator; it is insulated to prevent the access of external heat to the cold brine inside.

In this type of evaporator the cold brine is drawn off by a pump and circulated through pipes, &c., where the cooling effect is desired, returning

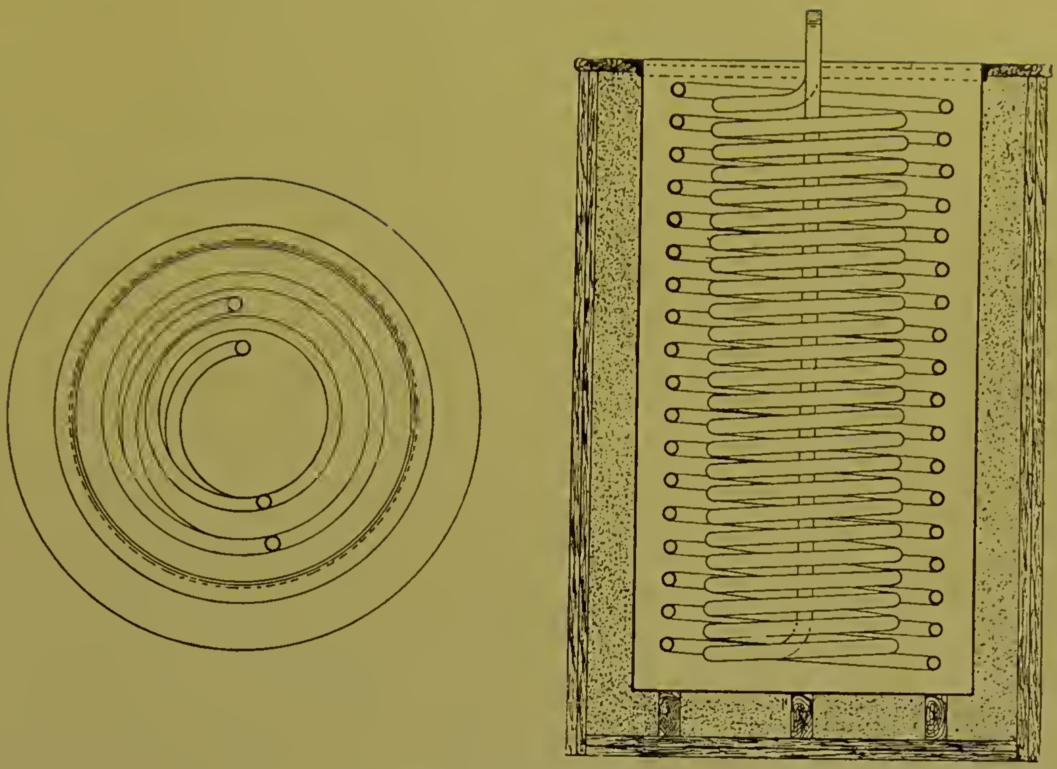


Fig. 13.—Two-coil Evaporator (Section)

Diagram illustrating the evaporator-coils of a refrigeration machine. The tank in which they are placed is lagged so as to lessen radiation.

by gravity to the evaporator to be cooled again. In small installations, where the machine is applied to the cooling of a room, the evaporator is frequently a narrow flat tank, placed inside the space to be cooled. It is enclosed by a partition, and the air of the cold-room is circulated over it by a fan. Very often the evaporator-tank is done away with, and the evaporator-coils alone are placed in the room to be cooled. This is known as " cooling by direct expansion."

Fig. 14 shows a corresponding condenser ; it is called the " submerged type." The cooling-water comes in at the bottom of the tank and overflows at the top.

Where cooling-water is scarce, or in large installations where it is desirable to economise its use, the evaporative condenser is frequently used. The coils are arranged vertically over a water-tank with a distributing pipe above the coils, through which water, drawn from the tank by a pump, is circulated and drips over the coils and back into the tank. About 10 per cent. on the average is lost by evaporation, but this evaporation cools it sufficiently to enable it to be at once used over again. These condensers should be placed on a roof in the open, so that a free circulation of air may be obtained to promote evaporation.

A new and distinct form of condenser, hailing from America, is shown in Fig. 15. It consists of two sets of pipes inside one another. Water passes through the central pipes, which are connected into a series at the ends. The outside pipes are also connected together in the same manner,

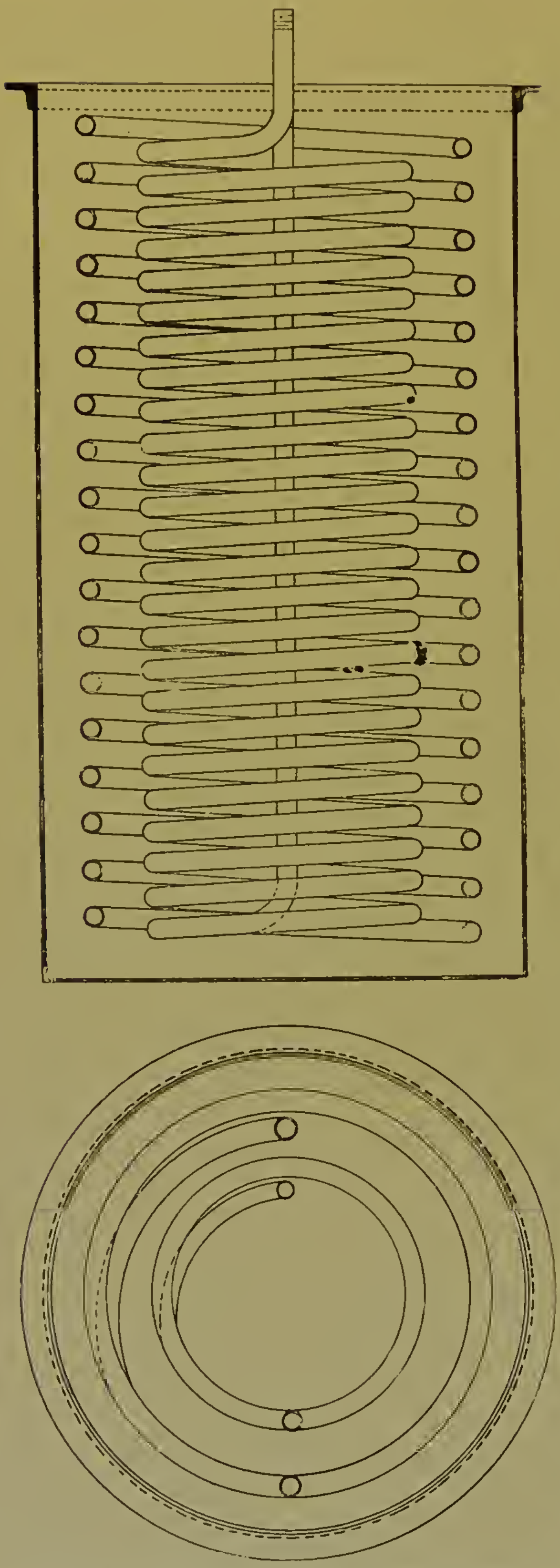


Fig. 14.—Diagram showing the Construction of the Condenser-coils in a Refrigerating-machine

The tank in which they are placed is not usually insulated.

and the gas to be condensed passes along in the annular space between the two pipes. The arrangement is counter-current, *i.e.* the water flows in one direction and the gas in the other. In this way a very high efficiency is obtained, the cooling-water being nearly up to the temperature of the incoming gas when it leaves the apparatus, and a much shorter length of piping is required than with either of the other condensers.

The coils of piping in condensers and evaporators are made of wrought iron or mild steel, usually lap-welded, and joined together in one continuous run without joints by electric welding. For carbonic anhydride they are tested to 2000–3000 lb. per square inch, but 500 is sufficient for the other refrigerants.

The regulating valve, generally of the screw-down type, must have a fine adjustment; this is especially necessary with carbonic anhydride. With sulphurous anhydride a less delicate adjustment is sufficient, as the amount of gas passing for a given amount of refrigeration is in the latter case about twenty-nine times as much as in the former.

We have already given some hints regarding the means of conveying the cooling effect from the machine to where it is required. Where the brine-evaporator is in use, the cold brine is circulated through long runs of wrought-iron pipe, measuring a good many miles in large installations. The piping is fixed to the ceiling of the cold-rooms. Any type of pump may be used for the circulation; the commonest are of the centrifugal, plunger, or positive-acting rotary type. A very efficient appliance for cooling cold stores is the brine-drums shown in Fig. 16. It consists of a thin galvanised pipe 8 or 9 in. in diameter, with stop ends, each drum being connected to the next by end-bends, so as to form a series. In the figure (Fig. 16) four drums are thus connected; they are placed on the ceiling of the room to be cooled, and the brine circulated through them by means of a pump. They present a large surface for the absorption of heat, and the walls being thin, the transfer to the brine is rapid.

The brine from the evaporator is generally at a temperature of from zero to 20° Fahr., and the moisture in the air of the cold-room is deposited as frost on the surface of the brine-drums. When the machine stops working, the frost gradually melts and would drop on the floor—rotting it, and gradually penetrating to the insulation and spoiling it, and at the same time rendering the atmosphere of the room damp and unsanitary. To prevent this, shallow wooden trays lined with zinc and called "drip-chutes" are hung beneath the brine-drums, and by their aid the moisture is conducted where it will be harmless.

Another method of transferring the cooling effect is by means of the air-cooler, which consists of coils of pipes stacked together in a separate insulated room. In these coils brine is circulated from the evaporator, or the evaporator is eliminated, and the liquid refrigerant expanded directly in the air-cooler coils. The air of the room, or rooms, to be cooled is drawn by a fan through a system of wooden air-trunks (suction-ducts) with ports and regulating slides at short intervals, so adjusted that equal quantities of air are drawn through each port. The fan drives the air over the coils, where it is cooled and sent along a corresponding set of delivery-ducts on the

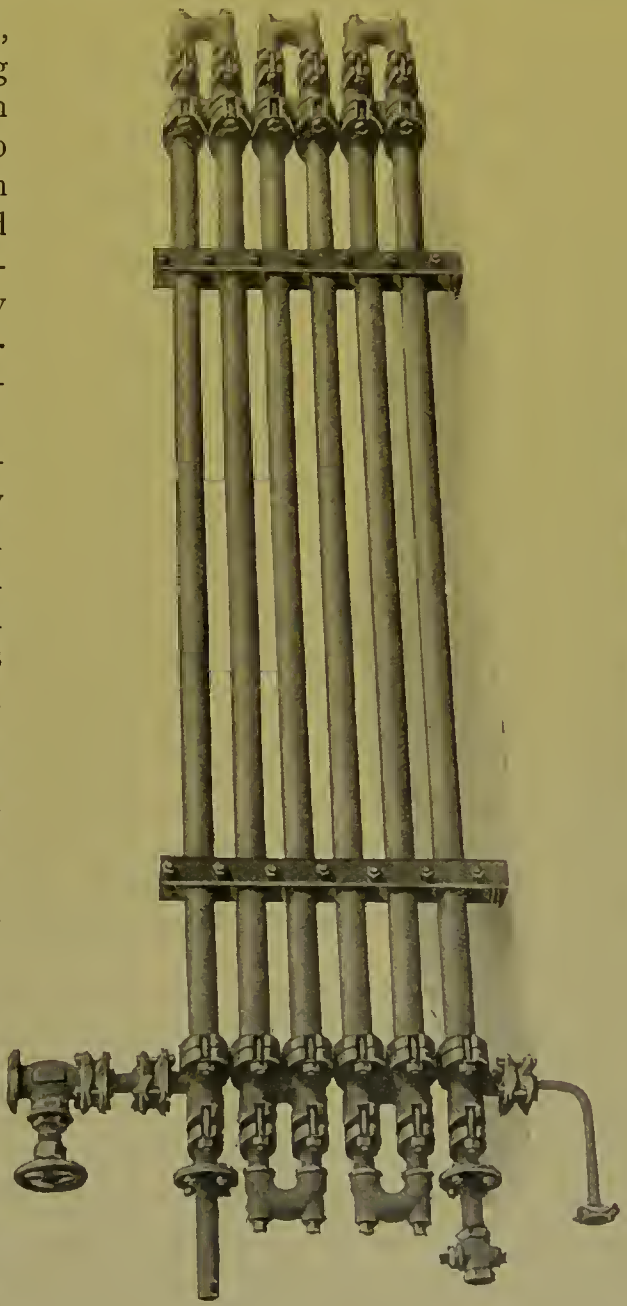


Fig. 15.—Double-pipe Condenser (Sterne)

opposite sides of the rooms. Quite a number of rooms can be cooled by one air-cooler.

The brine so frequently referred to is a liquid, unfreezable at the lowest temperatures attained in practical refrigeration. It is made by dissolving some material in water, which has the effect of greatly lowering the freezing-point of the latter. Common salt and calcium-chloride brines are both in use; the former is the cheaper, but it is almost obsolete because of its corrosive effect on metallic surfaces. Calcium chloride, which is free from this defect, is a by-product of the alkali works, and is now prepared on a very large scale for use in refrigerating installations.

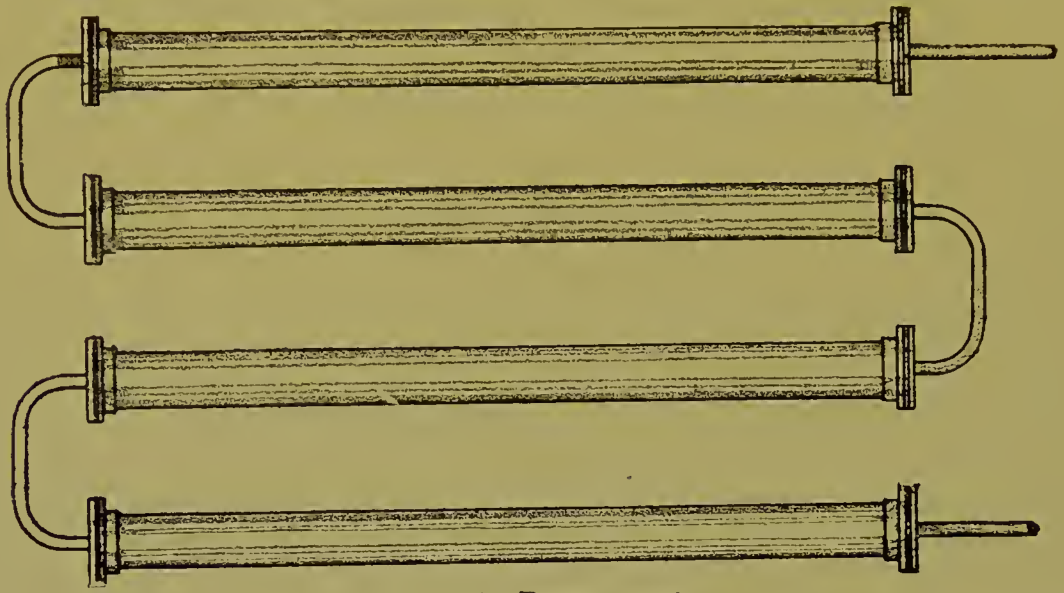


FIG. 16.—BRINE-DRUMS

The strength of the brine is generally about 1.17 specific gravity, equal to 34° Twaddell or 23° Beaumé.

The following Table gives the freezing-point of calcium-chloride brine of different strengths.

PROPERTIES OF CALCIUM-CHLORIDE BRINE

Salinometer Degrees.	Baumé Degrees.	Twaddell Degrees.	Specific Gravity Water = 1.	Calcium Chloride per cent.	Freezing-point, Deg. Fahr.
4	1	1.4	1.007	1	+31.10
22	5.5	8.2	1.041	5	+27.68
44	11	17.	1.085	10	+21.30
68	17	26.2	1.131	15	+12.20
88	22	35.8	1.179	20	— 1.40
108	27	45.8	1.229	25	—21.80

Insulation. The insulating of cold-rooms, ships'-holds for frozen meat, &c., is a very important matter. Even the best insulation is not perfect, but permits the in-leakage of a considerable amount of heat, which increases the burden on the refrigerating-machine and raises the

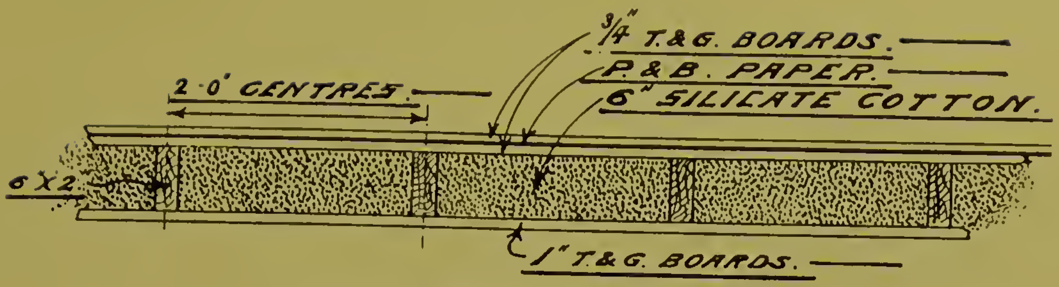


FIG. 17.—SECTION OF INSULATION

costs of working by a considerable percentage, and the question of how much additional capital it will pay to sink in improved insulation is one well worthy of consideration.

The majority of engineers have arrived at the rough practical formula that 6 in. of insulating material (silicate or charcoal) is good enough for temperatures over the freezing-point, and 8 in. for lower temperatures. Some account has already been given of the principal insulating materials, and we now (Fig. 17) illustrate a section of ordinary 6-in. insulation. It consists of 2 × 6 battens as framework spaced 2 ft. apart; lined on one side with two layers of $\frac{3}{4}$-in. matching, with tar-paper between, and on the other side with one layer of 1-in. matching. Sometimes both sides are lined with two layers of matching, and occasionally this is all of 1-in. section. The silicate or charcoal is packed between the battens. The doors are built up in the same way, and the frame tapers inwards to secure a tight fit. Heavy hinges are required and lever fasteners to wedge the door into the frame. Fig. 18 is the section of a cold-room door. Fig. 19, a single-lever fastener opening from the outside only; and Fig. 20, a double-lever fastener opening the door both outside and inside—a great convenience in large rooms, such as curing-cellars, where people may sometimes be accidentally shut in.

The Ideal Installation. Cold storages are not always designed to the best advantage. In the circumscribed conditions of large towns it is generally difficult to devise an ideal installation. But even where plenty of space is available, it is not always remembered that the hot engine and boiler rooms should be kept separate from the cold storage, and that the latter should have the smallest wall surface possible in

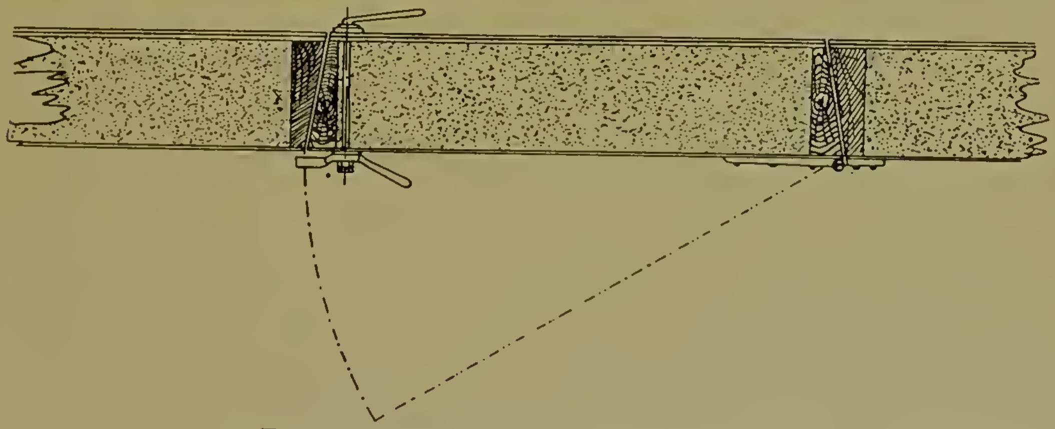


FIG. 18.—SECTION OF A COLD-ROOM DOOR

relation to the enclosed space; in other words, the shape aimed at should be the cube. In this way we obtain the maximum of cold-storage space with the minimum of enclosing walls, with the additional advantage, that as the in-leakage of heat takes place through the walls, and is a matter of so many thermal units per square foot of wall space, or insulation; in a given time, this also is reduced to a minimum.

The ideal block of cold stores should have the same length, breadth and height, the outside walls, ceiling and floor should be thickly insulated, while thinner insulation will suffice for the intermediate floors and partitions. The rooms should open into an insulated passage or air-well, also having insulated doors to be kept shut while the room doors are open. In this way the leakage of cold air from the rooms is minimised. The boiler- and engine-house should abut against one side of the cold-room block, and an extra partition with a dead air-space between it and the walls of the cold-room block will prevent the passage of much heat through the latter.

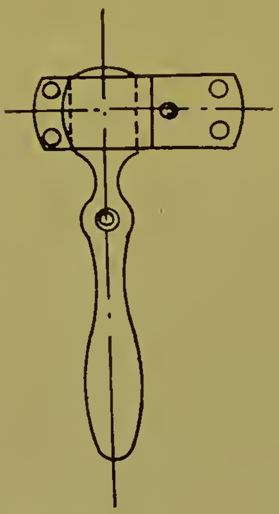


Fig. 19.—Single-lever Fastener

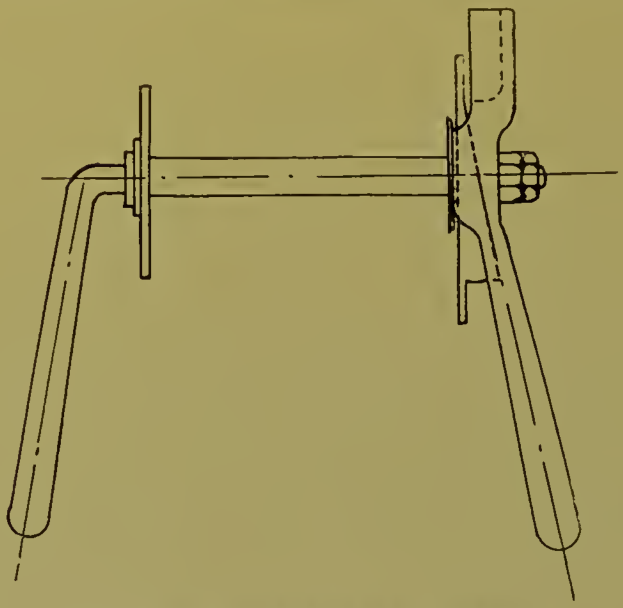
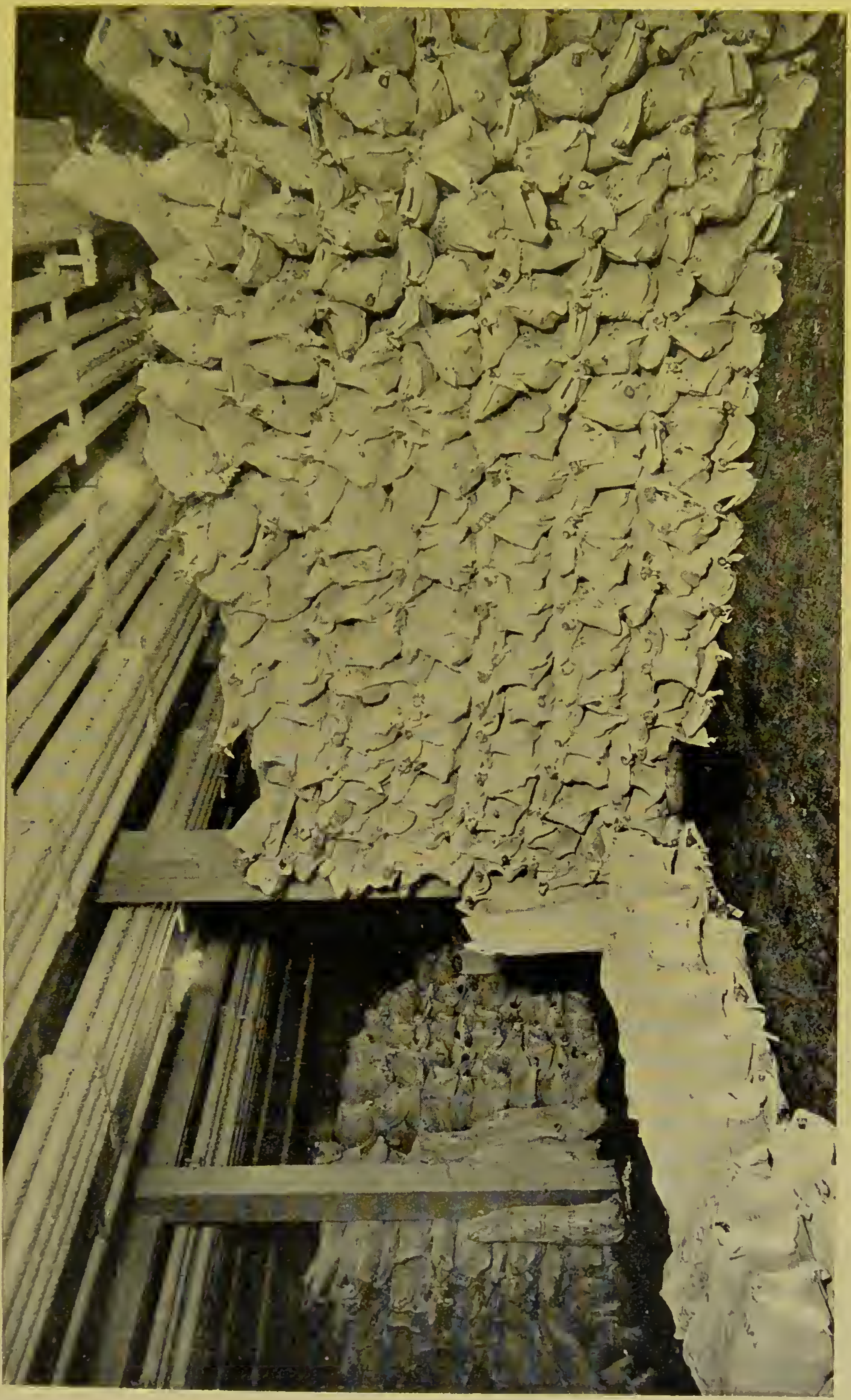


Fig. 20.—Double-lever Fastener

In the working of refrigerating installations the thermometer is of the greatest importance, and many different forms have been devised for determining the temperatures of the brine, and of the cold-rooms. Plain thermometers may be hung up in the cold-rooms. To avoid opening the doors little ports are sometimes cut in the insulation, and double-glazed air-tight, which provides a dead air-space between. The thermometer hung up behind the inner glass can be read from the outside. The "drop" thermometer is attached by a chain to a plug, which passes in a slanting way through the insulation; on pulling out the plug, the thermometer comes with it. Another form is the right-angled thermometer, the horizontal arm of which goes through the insulation, and the readings can be taken from the vertical scale outside. Very useful thermometers are made for determining the internal temperature of



Frozen Meat in Cold Store belonging to the Government's Produce Department, Adelaide, South Australia meat being chilled; they have a sharp metal point for penetrating the tissues. The electrical thermometer is undoubtedly the instrument of the future; by it the temperatures in any of the rooms can be read off in the engine-room or in the manager's office.

It is of some consequence to know the proportion of moisture in cold-rooms, and this is measured by the "hygrometer" or "dry and wet bulb" thermometer, a double instrument with one bulb exposed to the air, and the other kept moistened by covering it with a piece of muslin which dips into a little vessel of water, and draws up moisture continually by capillary attraction. The difference in the readings of the dry and wet thermometer referred to Glaisher's Tables gives the percentage of humidity in the air.

Poultry is now kept extensively in cold store, and the illustration shows one of the rooms belonging to a wholesale poultry store (Messrs. Wake, Ltd.) at Lurgan, Ireland.

Heat in Refrigerating Work. The measurement of heat in connection with refrigerating work is made in this country on the basis of the British thermal unit (B.T.U.), which is the amount of heat required to raise the temperature of one pound of water 1° Fahr. On the Continent the unit is the calorie or the amount of heat required to raise one kilogram of water 1° Cent. or nearly four times the amount of the B.T.U.

A refrigerating-machine is rated as being capable of eliminating so many B.T.U.s per hour, and from this figure its ice-making capacity can be calculated. It is found in practice that on the average the B.T.U.s required to be eliminated to produce one ton of ice, are equal to the B.T.U.s yielded by the melting of two tons of ice, therefore a machine capable of making one ton of ice in twenty-four hours is described as a two-ton machine, *i.e.* it produces a refrigerating effect equal to the melting of two tons of ice. This distinction requires to be carefully

Freezing-room for Beef at the Meat Export Works, Queensland

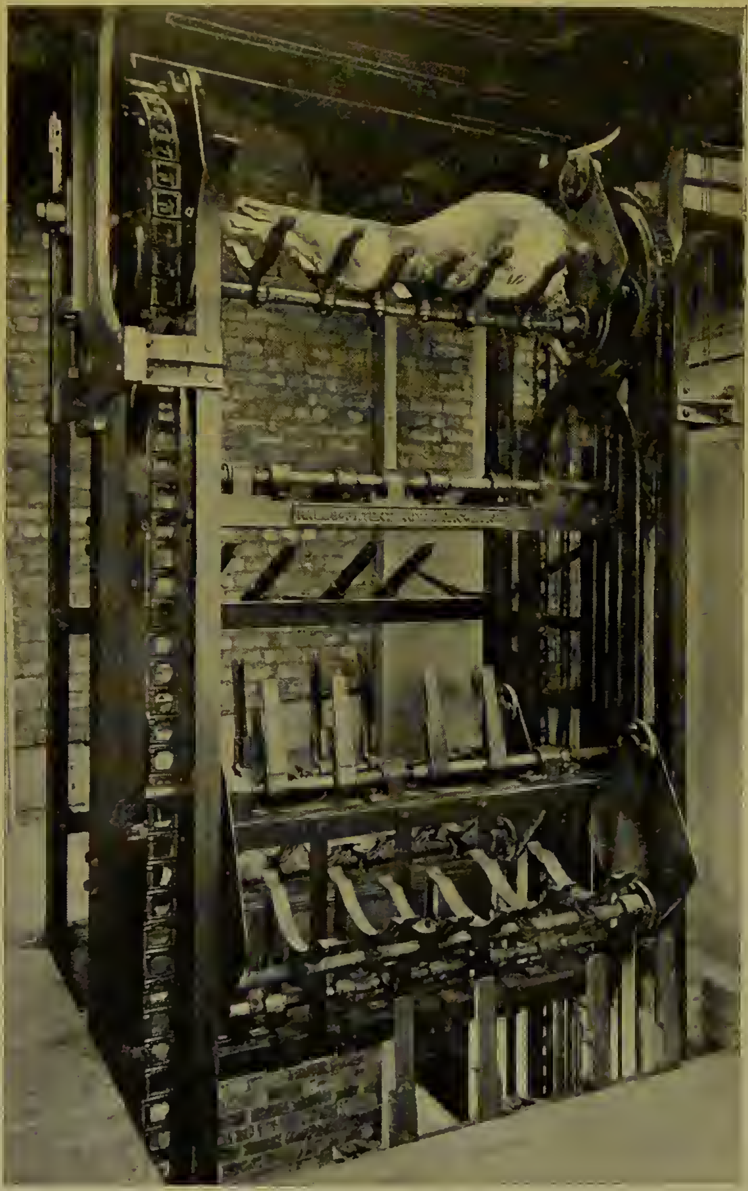
kept in mind by purchasers of refrigerating machinery. The man who bought a " ten-ton " machine with the expectation of getting ten tons of ice from it in twenty-four hours, would find that he had overrated the capacity of his purchase by five tons.

Marine installations do not differ materially from those on land, with the exception that the machinery for the former is made as compact as possible. Carbonic anhydride has attained the position of the leading refrigerant for ship work, chiefly on account of its inodorousness. Engineers do not care to face the risks connected with the possibility of the escape of pungent gases in the confined engine-rooms of ships. Still, a good many ammonia installations are in use, and sulphurous anhydride machines are not unknown. The latter refrigerant with its low pressure has great advantages for tropical work, while carbonic falls off very much under such conditions. Indeed, with the high temperature of the cooling water available in tropical seas, the " critical point " of the liquefaction of carbonic anhydride is frequently passed, *i.e.* the temperature in the condenser is so high that no available pressure is sufficient to condense the gas into a liquid, with the result that the compressor becomes a sort of cold-air machine, and falls off enormously in efficiency.

The Transport of Frozen Meat. Brine circulation through pipes is the favourite method of distributing the cooling effect in refrigerated ships. With the increase in the trade in chilled beef, a call has come for steady and uniform temperatures, as the goods must be held at one point of the thermometer all through the voyage. This requires a good deal more care than with frozen meat with a temperature of, say, 16 to 24° Fahr. It is accomplished by (1) careful packing of the meat, with air-spaces all about it; (2) accurate thermometers properly distributed, and frequently read off; (3) the provision of a large bulk of brine, which is circulated at only a few degrees higher temperature than that of the holds.

Notwithstanding some improvements in late years, the arrangements for the handling and transport of frozen meat in this country are still very primitive, and contrast painfully with the careful methods in the Colonies and foreign countries from which the meat is shipped.

The cargo is delivered into lighters, carts or railway vans, the latter of which have sometimes the word "refrigerator" painted on them, but in some cases this is all the connection they have with refrigeration. The consequence is that the meat is frequently partially thawed before it reaches the cold-stores in which it is held until required for consumption, and this means deterioration of quality. The ideal cold-stores for receiving cargoes of frozen meat should be alongside the landing wharf, and the goods transferred rapidly by mechanical conveyors from the ship to the store. The railway companies in this country have been a long time in beginning to develop a really efficient refrigerator service. In the United States many thousand railway vans, insulated and cooled by ice, are in use, and even Russia has made great progress in this direction. Attempts have been made with some success to run refrigerator trains cooled by machinery, but this department is still in the early stages of its development.

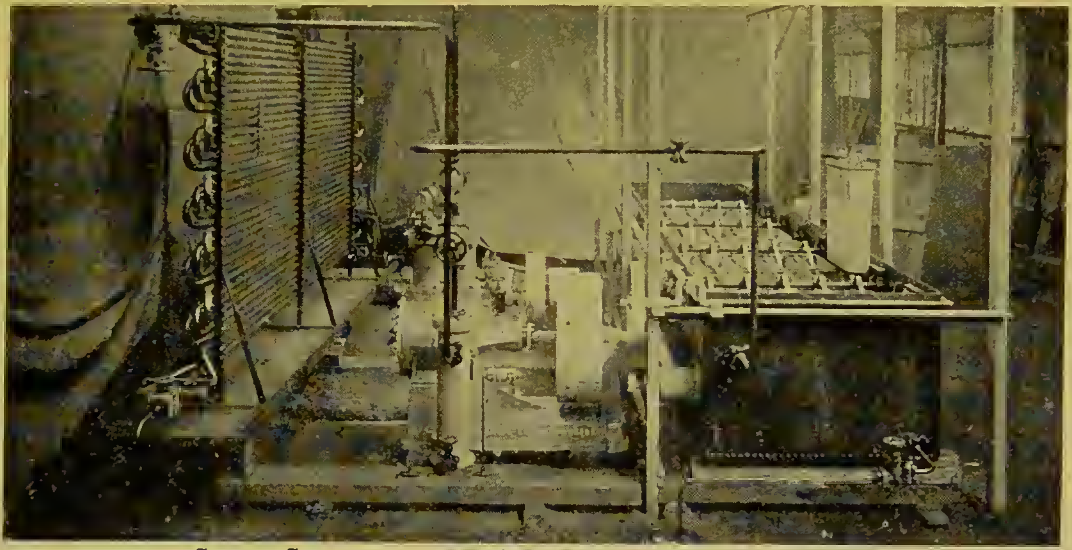


Elevator in Cold Store

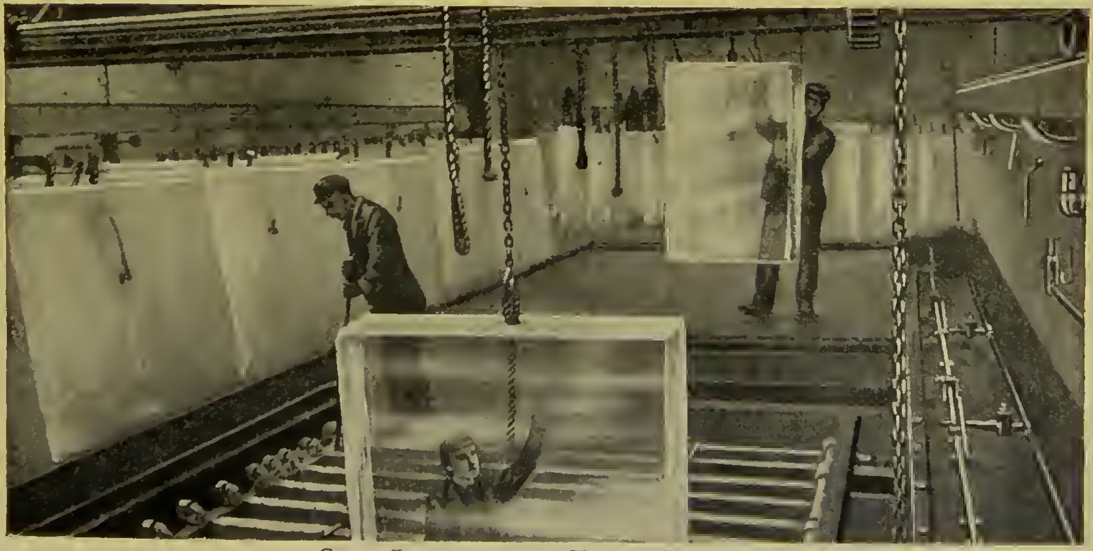
Showing method of raising frozen mutton carcases, by means of a hoist, to the different floors.

The Manufacture of Ice. Ice is now

One of the particular uses to which refrigeration has been put is the chilling and freezing of carcases of meat in the British Colonies for export to the United Kingdom. In this picture the frozen carcases are shown being transferred from railway waggons to ships at Port Chalmers, New Zealand.



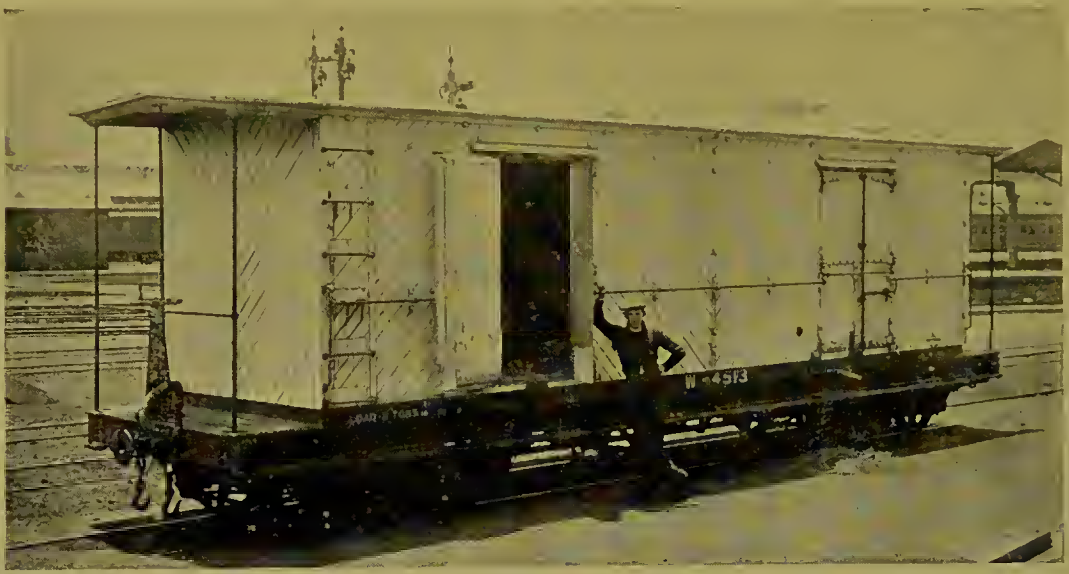
SMALL SELF-CONTAINED ICE-MAKING PLANT (HASLAM)



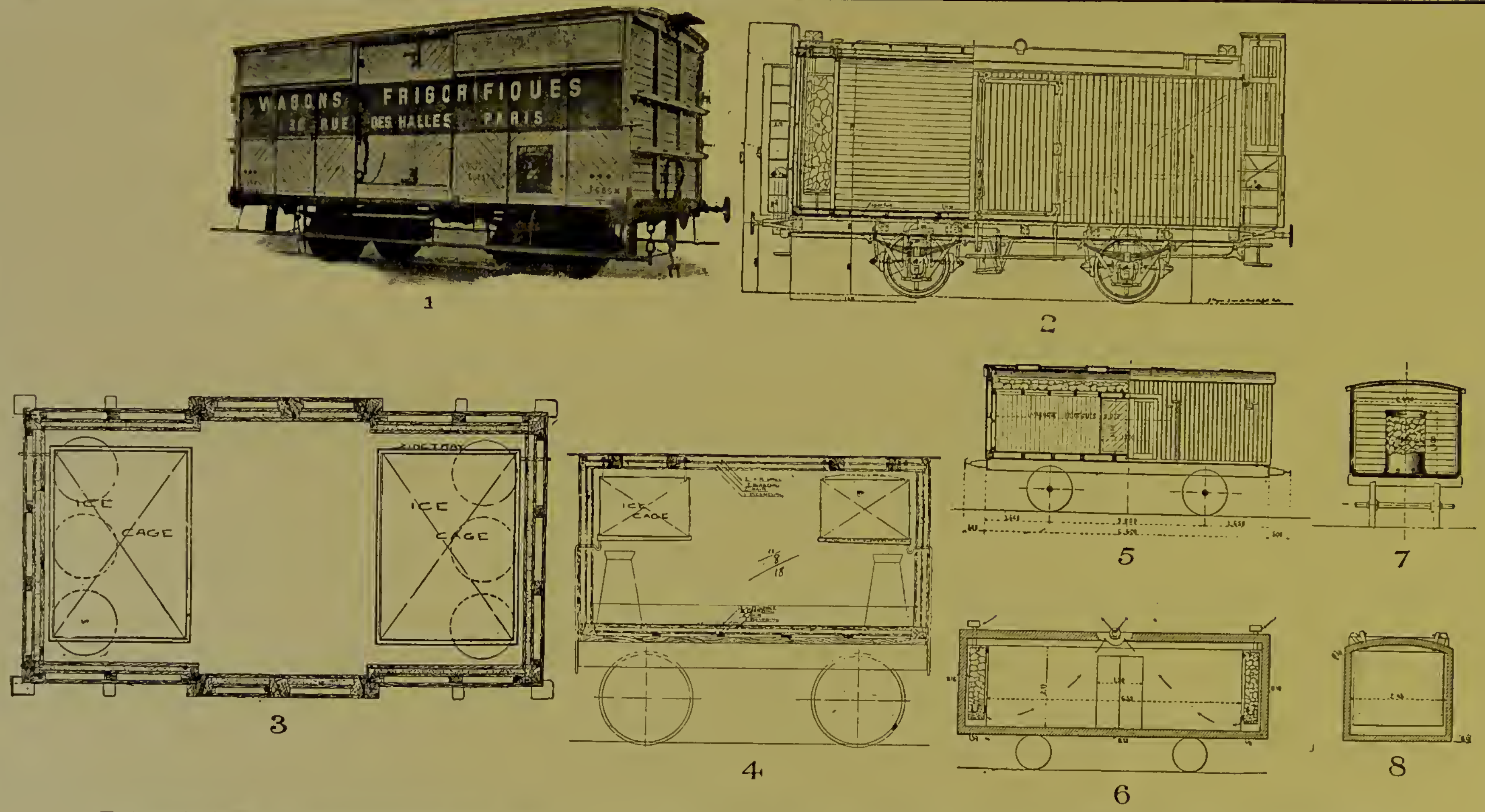
CELL ICE-FREEZING TANK (STERNE)

manufactured artificially on a large scale, and a considerable proportion of it, and also of the natural ice imported, is consumed in the cold-rooms of meat-purveyors. Several different systems are in use for ice-making; the compressors, condensers, evaporators, &c., are the same as for cold-storage work, in fact, the two industries are frequently combined. The additional plant required for ice-making may be divided into three kinds, (1) the can, (2) the plate and (3) the cell, systems.

The can-ice plant is composed of a tank, sometimes built of concrete, and even of wood, but generally of wrought iron, insulated with silicate cotton or some other material. In this tank a number of moulds made of thin steel galvanised, and of the shape of the blocks of ice, and filled with the water to be frozen, are stood. A current of cold brine from the evaporator of the refrigerating machine is circulated round them by the brine pump. In a period of from twelve to forty-eight hours, or even longer, according to the thickness of the blocks of ice required, the water in the moulds is frozen solid. The moulds are lifted out and dipped for a moment in warm water, which thaws a thin film of ice next the metal, and the block then readily slides out of the mould. Can ice made in this way is somewhat opaque from bubbles of air frozen in it, and when clear ice is wanted, arrangements are made for slightly agitating the water during the freezing process, which causes the small bubbles of air to rise to the top and disappear. Natural water contains air in solution, but the solubility decreases as the temperature is lowered, hence, when the freezing-point is approached the air in solution separates as minute bubbles of gas. Where the water-supply is of doubtful quality it is purified by distillation before freezing, and with proper arrangements this water may be kept free from dissolved air. An illustration is given (on p. 585) of a small ice-making plant on the above system, photographed as set up in the fitting-shop, and before the ice-tank has been insulated.



Refrigerated Waggon in Western Australia



1, External view of French refrigerating waggon; 2, French refrigerated waggon; 3, Railway waggon for carrying milk; ground plan showing position of ice cages; 4, Railway waggon for carrying milk, showing arrangement of ice; 5 and 7, Details of refrigerated waggon, showing arrangement of the ice; 6 and 8, Diagram showing the interior of a railway waggon with ventilating arrangement on the roof.

In this case the evaporator has been eliminated and the cooling of the brine in the tank effected by direct expansion coils, placed between the ice-moulds.

The refrigerator in the centre is of the vertical enclosed belt-driven type ; the condenser on the left, of the evaporative type, and the ice-tank is shown on the right, with an ice-mould drawn up to show its general appearance.

A modification of this system is the ice-tank, with a partition for the accommodation of the direct expansion coils. The partition has ports connecting the coil space with the freezing space, and the brine is circulated continuously over the expansion pipes and among the ice-moulds by a propeller.

In the plate system an insulated tank is also used, but instead of moulds surrounded by brine, we have sections carried across it at intervals, composed of two plates enclosing a narrow space in which the cold brine is circulated, or direct expansion pipes placed in still brine. The spaces between the sections are filled with the water to be frozen, and the ice forms on the walls of the sections, increasing in thickness the longer the process is kept going. As only a portion of the water is frozen, and as ice tends to crystallise pure, a good clear product is obtained by this process, even from somewhat impure water, the air-bubbles and other impurities being projected into the water which remains unfrozen. The plates of ice are thawed off by circulating warm brine in the sections. They are then drawn out, and sawn into suitable sizes for use.

The cell system is a sort of cross between the two previous ones , it has the sections of the plate system, but the spaces between are again divided by cross divisions into several compartments called " cells," the water in each of these being entirely frozen into blocks, otherwise the making is similar to that of the plate system.

Our illustration (on p. 585) shows a freezing-tank in the cell system. Agitating gear for clearing the ice is necessary as in the can system.

Ice made in the winter when the demand is small is frequently stored up in insulated rooms till the hot weather arrives, and it has been found that the loss by melting can be economically diminished by circulating cold brine through a set of pipes on the ceiling, or by having direct expansion pipes in the same position.

We have dealt with refrigeration hitherto, simply as a preservative agent, but it has another very important application to meat, *i.e.* that of maturing it. When meat has been hung for some weeks in a cold-store, it not only comes out perfectly fresh, but much tenderer than when it went in. Then there is the advantage, which will tend to disappear as refrigeration becomes more general, to the man with some capital and a good cold-store, of being able to buy largely when there is a glut, and hold until prices are better.

Much remains to be done before refrigeration has exhausted the tale of service it is capable of rendering in the handling of meat, but the industry is in its youth, and shows every sign of continued growth and development.

MICRO-ORGANISMS IN COLD-ROOMS

As we have seen, the preservative effect of refrigeration on meat and other perishable goods is due to the fact that at low temperatures the bacteria which cause decomposition either do not increase at all, or their growth and development take place at a greatly diminished rate. They are not as a rule killed out by cold, although their numbers decrease very much when exposed for lengthened periods to very low temperatures. Thus it has been shown that ice from contaminated sources tends to clear itself of germs in prolonged storage. In cold-rooms, however, there is apt to be a continued access of fresh germs from one source or another, and infection is likely to grow rather than to diminish. especially when temperatures are above the freezing-point, and a damp and stagnant atmosphere is allowed to prevail. It is a good practice to disinfect cold-rooms occasionally; this may be accomplished by sealing up all openings and liberating quantities of sulphurous anhydride or formalin gas in the rooms, in proportion to their size. The sulphurous anhydride used for charging the refrigerating machine, where this system is installed, can be readily made use of for the purpose, a cylinder containing the proper quantity being opened in the room and left there, the door of course being tightly closed. Formalin gas can also be easily used, mixtures producing it being sold, which are simply put into wide shallow tins in the room, and the gas allowed to boil off. Thorough ventilation must follow in each case.

The amount of work which has been done in the investigation of the subject of bacteria in cold-rooms is not very great, but it is now attracting some attention, and, as the tendency is continually to put refrigeration to more delicate uses such as the transport and storage of soft fruits, it will doubtless receive more attention in the future.

Berlin Experiments and their Result. It is sometimes claimed by makers of refrigerating machinery that the particular appliances they use for transmitting the cooling effect, clear the atmosphere of the cold-rooms of bacteria. To determine this point some experiments were made in Berlin in the years 1903–5 by Baier, Bougert and Stetefeld, and we will first give an account of those in connection with the dry air-cooler which is most used in this country, and which has been already described. The method employed was to expose culture plates in the air of the suction ducts, *i.e.* before passing from the room to the air-cooler, and also in the air of the pressure or delivery ducts, *i.e.* after it had passed over the cooling coils, and was on its way back to the room. The plates were then incubated in the usual manner, and micro-photographs taken of them, and the colonies of bacteria developed were counted. If the air-cooler had the effect of diminishing the numbers of the bacteria, this would be shown in the smaller number of colonies in the plates exposed in the pressure or delivery ducts. Curiously enough, in nearly every case, the result was exactly the opposite, showing that the air was rather contaminated than cleansed in the dry air-cooler. The experiments are summed up in the following Table :

Tests carried out in the Cooling Stores of the Berlin Central Market Hall

(Dry air-cooling, Fixary System—Humboldt)

Date of test.	Place where the culture-plates were exposed to the air-current.	Number of colonies on plate when taken out of propagating apparatus.
Sept. 28, 1904.	Air-cooler No. 1, pressure air-duct behind the cooler, second portion of expansion-pipes thawed off . .	137 colonies (Fig. 16).
	Pressure air-duct in the chill-room .	83 single colonies (Fig. 17).
	Suction air-duct in the chill-room .	81 single colonies, many small ones (Fig. 19).
Sept. 30, 1904.	Air-cooler No. 1.	
	(*a*) Suction air-duct immediately before the cooler, first part of expansion-pipes thawed off . .	37 colonies.
	(*b*) Pressure air-duct at its entrance to the chill-room, second part of expansion-pipes frozen . . .	75 ,,
	Air-cooler No. 2.	
	(*a*) Suction air-duct at entrance to cooler, first part of expansion-pipes thawing off	51 ,,
	(*b*) Pressure air-duct at outlet of cooler, second part of expansion-pipes frozen	59 ,,
	Air-cooler No. 3 for chill-room containing livers and entrails.	
	(*a*) Entrance to cooler, first part of expansion-pipes frozen . .	36 ,,
	(*b*) Outlet of cooler, second part of expansion-pipes thawed off .	82 ,,
	Pressure air-duct in chill-room . .	161 single colonies and many small ones side by side (Fig. 18).
	Suction air-duct in the chill-room .	79 colonies. 134 large single colonies and many small ones.
Oct. 8, 1904.	Air-cooler No. 2.	
	(*a*) Suction air-duct entrance to cooler, first part of expansion-pipes thawing off . . .	46 colonies (Fig. 20).
	(*b*) Pressure air-duct outlet of cooler, second part of expansion-pipes frozen	181 colonies (Fig. 21).
Repeated test.	Air-cooler No. 2.	
	(*a*) Suction air-duct entrance to cooler, first part of expansion-pipes thawed off . . .	53 ,,
	(*b*) Pressure air-duct outlet of cooler, second part of expansion-pipes frozen	44 ,,
	Air-cooler for No. 3, for chill-room containing livers and entrails.	
	(*a*) Suction air-duct entrance to cooler, first part of expansion-pipes frozen	47 ,,

TESTS CARRIED OUT IN THE COOLING STORES OF THE BERLIN CENTRAL MARKET HALL—*continued*

Date of test.	Place where the culture-plates were exposed to the air-current.	Number of colonies on plate when taken out of propagating apparatus.
	(*b*) Pressure air-duct outlet of cooler, second part of expansion-pipes just beginning to thaw off . .	60 colonies.
	Pressure air-duct in chill-room . .	83 single colonies and many small ones.
	Suction air-duct in chill-room . .	54 colonies.

The illustrations which are arranged in a section by themselves at the end of this chapter show the photographs of some of the cultures referred to in the Table. The frost on the air-cooler pipes was allowed to thaw, and one half-centimetre of the water added to a sterile culture plate, and the colonies developed are shown in Fig. 22 (p. 607). Of course this plate is not comparable in a quantitative sense with the air-infected plates. The results seem to show that there is a tendency for bacteria to accumulate in dry air-coolers.

In the wet air-cooler, the air is brought into direct contact with the brine, which is either in the form of rain or in films brought up by wheels rotating in the cold brine tank, or the cold brine may be run down fixed vertical metal surfaces in the path of the air current. The objection to this air-cooler is that it is difficult to prevent brine spray being carried into the cold-room with the air-current, and that the brine itself absorbs gradually the foul gases, dust, &c., from the air passed over it, and becomes very impure.

Laboratory experiments, however, showed that very impure brine (salt and water brines were used) which had been in use for several years and contained bacteria in abundance together with bad-smelling gases and ammonia did not infect sterilised air when proper means were adopted for trapping the brine spray. The smallest proportion of brine spray carried infection with it. On the other hand, it was found that the brine spray deprived infected air of a considerable proportion of its bacteria.

The impure brine when allowed to settle clear, deposited a considerable proportion of its bacterial contents with the sediment. This is illustrated in the following Table, where the results are given of the bacteriological examination of both turbid and clear brines from several slaughterhouses using the wet air-cooler.

No	Origin of Brine and when Received.	Date of Bacteriological Test.	Number of Germs per 1 c.c. of Brine.
1	Sample No. 1. Slaughterhouse, Berlin taken from the cooler on November 17, 1903. Colour, red-brown turbid	November 18, 1903	50,000
		February 27, 1904	27,000
		September 24, 1904	1,500–2,000
		January 15, 1905 :	
		(*a*) Clear upper part of brine	250–300
		(*b*) Red-brown sediment of same	1,800–2,000
		(*c*) *a* and *b* mixed by agitation	500–1,000
2	Sample No. 2. Slaughterhouse, Berlin, taken on February 27, 1904. The brine, cleared and cleansed by settling, only showed small particles of sediment of iron oxide	February 27, 1904	80
		September 24, 1904	18
		January 18, 1905 :	
		(*a*) Clear upper part	Sterile.
		(*b*) Yellow sediment	15
		(*c*) *a* and *b* well mixed	5
3	Sample No. 3. Slaughterhouse, Berlin, taken September 16, 1904, after seven months' use in air-cooler	September 24, 1904	1,600–2,000
		January 15, 1905 :	
		(*a*) Clear upper part	100–120
		(*b*) Red-brown sediment	10,000–12,000
		(*c*) *a* and *b* well mixed	1,000–1,200
4	Sample No. 4. Slaughterhouse, Berlin, taken January 22, 1905. The brine had been cleared and cleansed during the winter season by sedimentation, and the upper clear part drawn off for use in the coming season	January 22, 1905	400–600
5	Sample No. 5. Slaughterhouse, Berlin, taken from the air-cooler for the pickling-room on January 22, 1905. The brine had not been cleared and cleansed.	January 22, 1905 :	
		(*a*) Clear upper part of brine	10
		(*b*) Sediment	160
		(*c*) *a* and *b* mixed	60
6	Sample from slaughterhouse, Kuestrin, received on March 5, 1904. Contained much iron oxide	March 5, 1904	50
		March 15, 1904	40
		January 15, 1905	Sterile.
7	Sample from slaughterhouse, Arnstadt, March 24, 1904. Clear	March 24, 1904	20
		January 15, 1905	10
8	Sample from slaughterhouse, Oberhausen, received on March 5, 1904	May 6, 1904	10,000–15,000
		January 15, 1905	150

The effect of the wet air-cooler in the air of cold-stores was tested on the large scale in the Berlin abattoir, and the following Table gives the results :

Bacteriological Tests carried out in the Cooling Stores of the Berlin Municipal Abattoir

(Wet air-cooler, Borsig system)

Date of test.	Place where the culture-plates were exposed to the air-current.	Number of colonies on plate when taken out of propagating apparatus.
Sept. 16, 1904. Large air-cooler.	No. 1. Suction air-duct before the air-cooler	78 colonies.
	No. 2. Delivery air-duct in the chill-room above the meat-cells	47 ,,
		130 ,,
Air-cooler for pickling-room.	No. 1. Suction-duct before air-cooler	5 colonies, 3 of these mould.
	No. 2. Delivery-duct immediately behind cooler (forced draught)	1416 colonies.
Sept. 22, 1904. Large air-cooler (tests repeated).	Suction-duct before cooler	34 colonies (Fig. 1).
		19 ,,
	Inside of air-cooler immediately behind brine spray	Innumerable colonies grown into one another (Fig. 2).
	Main delivery-duct in chill-room above cells	92 single colonies and a large number of small ones directly side by side.
	Side delivery-duct in chill-room	53 larger single colonies (Fig. 3).
	Side suction-duct in chill-room	82 single colonies (Fig. 4).
	Main suction-duct at the point where it leaves the chill-room	63 larger colonies and a great number of smaller ones side by side.
Air-cooler for pickling-room (tests repeated).	Suction-duct immediately before air-cooler	6 colonies (Fig. 5).
	Delivery-duct immediately behind cooler	Innumerable colonies side by side (Fig. 6).
	Delivery-duct in pickling-room	336 larger single colonies and many small ones.
	Suction-duct in pickling-room	82 colonies (Fig. 7).

Here we have general increased infection on the passage of the air through the wet cooler. The photographic plates illustrating the cultures are exhibited in Figs. 1 to 7.

As it was thought that the increased infection was due to the impure brine spray passing in with the air current, means were taken to remedy this. A wire grating was first interposed in the delivery duct, and the following are the tests made with it.

Date of test.	Place where the culture-plates were exposed to the air-current.	Number of colonies on plate when taken out of propagating apparatus.
Sept. 27, 1904. Test with wire-grate in pressure-duct behind air-cooler for pickling-room.	Suction air-duct before air-cooler	5 colonies.
	Pressure-duct behind wire-grate	576 ,,
	Pressure-duct in pickling-room	4 ,,
	Suction-duct in pickling-room at the point where it leaves the room	127 ,,

The results not being satisfactory a screen of birch branches was substituted for the wire gauze, and the figures obtained are summarised as under:

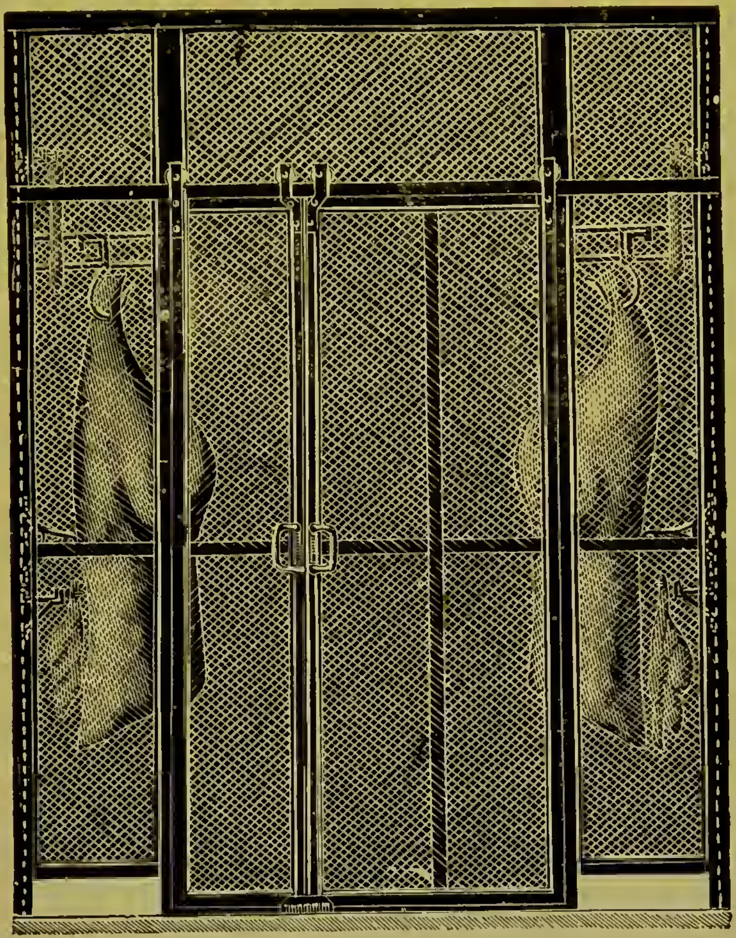
Date of test.	Place where the culture-plates were exposed to the air-current.	Number of colonies on plate when taken out of propagating apparatus.
Oct. 19, 1904.	Suction air-duct before the air-cooler	(*a*) 34 colonies (Fig. 8). (*b*) 12 ,, (*c*) 22 ,,
After the insertion of the birchbranches in the air-duct immediately behind the air-cooler, *b* and *c* give the results of the repeated tests on October 24 and 30, 1904.	Pressure air-duct behind the hedge of birches	(*a*) 13 colonies (Fig. 9), a second plate remained sterile. (*b*) 11 colonies, a second plate 5 colonies. (*c*) 17 colonies, a second plate sterile.
	Pressure air-duct in the pickle-room	(*a*) 4 colonies (Fig. 10). (*b*) 6 colonies. (*c*) 3 ,,
	Suction air-duct in the middle of the pickle-room	(*a*) 22 colonies (Fig. 11). (*b*) 36 colonies. (*c*) 29 ,,
	Suction air-duct at the spot where it leaves the pickle-room	(*a*) 37 colonies (Fig. 12), 4 colonies mould. (*b*) 57 colonies. (*c*) 63 ,,
	In the laboratory of the slaughterhouse	62 ,,
	In the machine-room of the cold storage plant	42 ,,
	In the refrigerator-room	57 ,,
	In the outer air	124 ,,

The birch branches caught and condensed quite a considerable proportion of brine spray and the Table shows a great improvement in the results. Obviously the increased contamination of the air was due entirely to the brine spray and we find that when this is arrested we have a considerable purifying effect as a result of passing the air through the wet brine cooler. Figs. 8 to 12 show the photographic plates of the cultures.

The culture-plates were exposed for three seconds to the infected air and while the brine-spray was not at work, and innumerable colonies of bacteria was the result (Fig. 13). When the brine-spray was turned on, practically the whole of the bacteria were removed (Fig. 14). On exposing another plate for five minutes, or 100 times longer, to the air-current cleansed with the brine-spray, 120 to 150 colonies were obtained (Fig. 15).

We cannot found very decided conclusions on these experiments, and more positive evidence must be forthcoming before judgment can be pronounced on the merits or demerits of either the dry or the wet cooler, in relation to the purity of the atmosphere of cold-rooms. It should be possible to ascertain directly the effect of the one cooler as compared with the other on the keeping quality of meat. All bacteria—in fact the majority—are not injurious, hence the mere counting of numbers carries us only a little way. It is, therefore, a pity that these investigations, so well begun, should not have been extended to the identification of the various bacteria found. There would seem to be an opportunity here for interesting and instructive research.

It will be noticed from the last line in the foregoing Table (*see* p. 594) that the air of the cold-rooms was much purer than that of the outside



Chill-room Cubicle in an Abattoir

In order that each meat-purveyor may have control of his own supplies and be able, at the same time, to use the cold storage at the abattoir, screened cubicles have been devised and have proved to be very useful.

mosphere, and it would have been interesting to have had a similar parison in connection with the experiments on the dry air-cooler.

n the Lindley process for the preservation of meat, the action of nalin-vapour in conjunction with refrigeration is made use of. has proved a very promising application in the carriage of chilled at from the Argentine and Australia. Hitherto meat from these arters has had to be frozen because of the long voyage, and the United ates have had something like a monopoly of the more profitable chilled-eat trade.

ABATTOIR REFRIGERATION

The refrigerating machinery and the means for transmitting the cooling effect are the same in abattoir installations as in general cold-stores. In the latter, however, many different kinds of produce are stored which if placed together in the same room would, in many cases, injuriously affect one another. For example: strong-smelling materials such as cheese dried fish, &c. &c., would tend to injure the delicate flavour of milk cream, butter, &c. Then, many materials require to be stored at different temperatures, and the result is that the ordinary cold-stores must be made up of a great many rooms held at several different degrees of temperature and completely isolated from one another, each room being provided with separate cooling appliances. In the public abattoir the requirements are much simpler. Only one temperature, as a rule, is aimed at or required, and this is fixed at a few degrees above the freezing-point. Then all the produce can be stored together without mutual injury. The only point which requires attention is the separation of one user's property from that of another. It is the custom, especially in Germany, for meat-purveyors to rent refrigerated space in the public abattoirs in which to store the carcases belonging to them until required. The best form of cold-store in an abattoir, therefore, is that which consists of one large room insulated in the usual manner, with cubicles formed inside and made lock-fast for the purposes of private users, while the balance of the space in the large room forms the general cold-store for the abattoir where carcases can be left in the charge of the officials at a rate of so much per carcase per day or week, or the cubicles may be rented by the year. The cubicles should be provided with locks, all with different keys, but opening with one master-key in the possession of the officials, so that they can enter at any time in case of necessity.

Our illustration gives the front view of such a cubicle. It is constructed of angle and tee-iron framework filled up with galvanised wire-work. Instead of the latter, perforated or slotted plates may be used, the object being, to have open walls so that the circulation of cold air about the carcases will be as little interfered with as possible.

The overhead trackways of the abattoir may have branches from them connected into the cubicles, and in this way the handling of the carcases is facilitated. In abattoir installations the best method of cooling is the cold-air system, the chilled air being distributed by trunks with regulating slides at intervals, so that the cooling effect is equally distributed over the whole room.

BACTERIA IN THE COLD ROOM

THE BERLIN EXPERIMENTS ILLUSTRATED

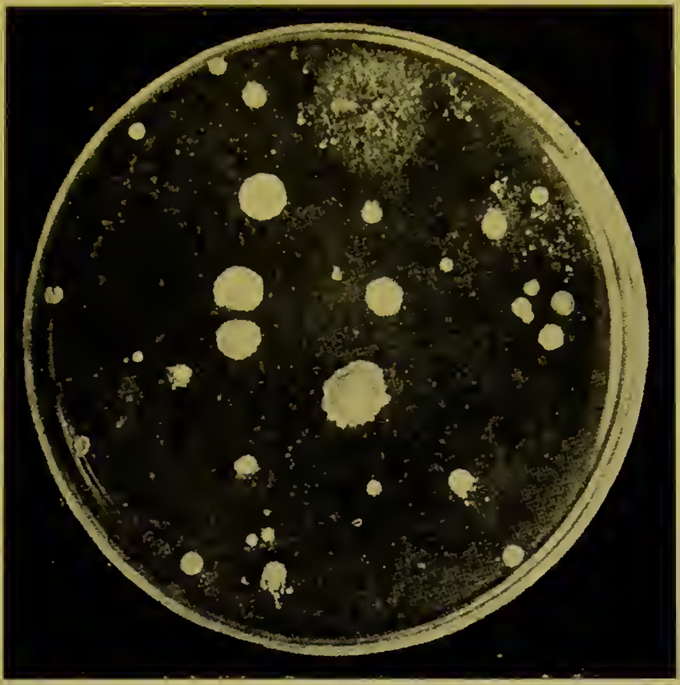


Fig. 1.—34 Colonies

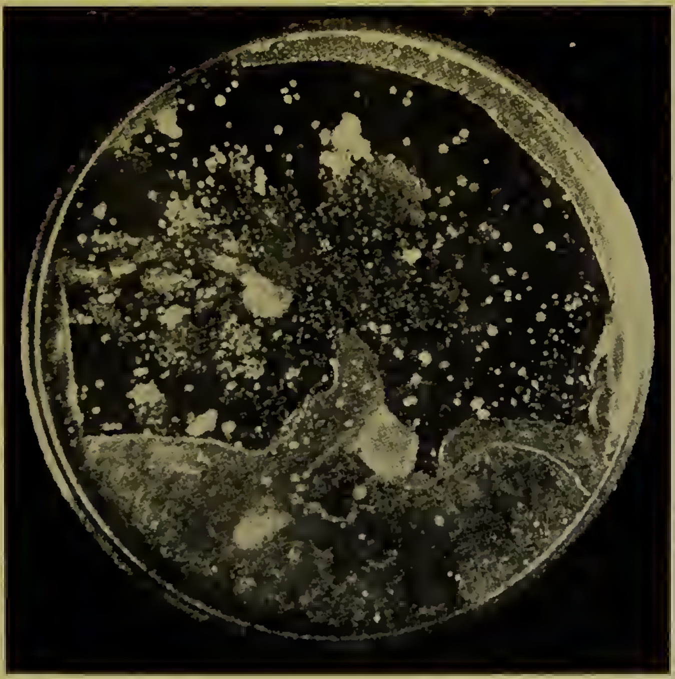


Fig. 2.—Innumerable Colonies

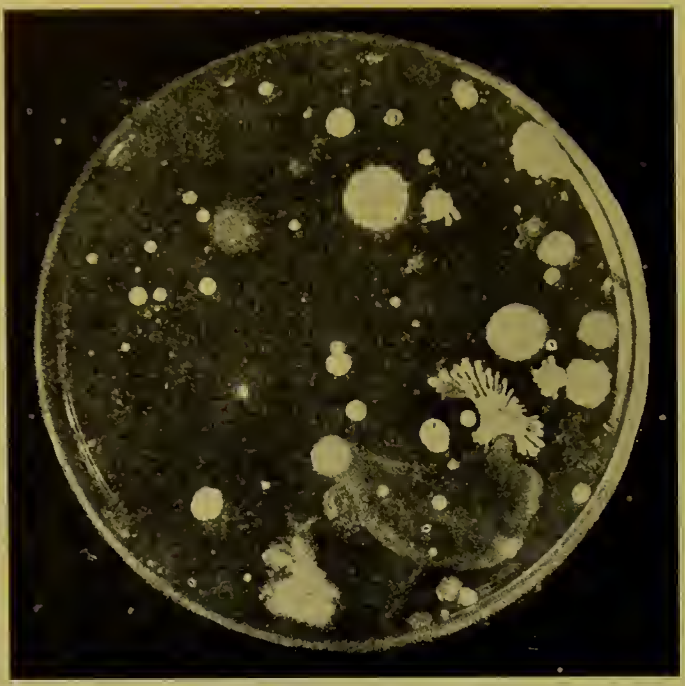


Fig. 3.—53 Colonies

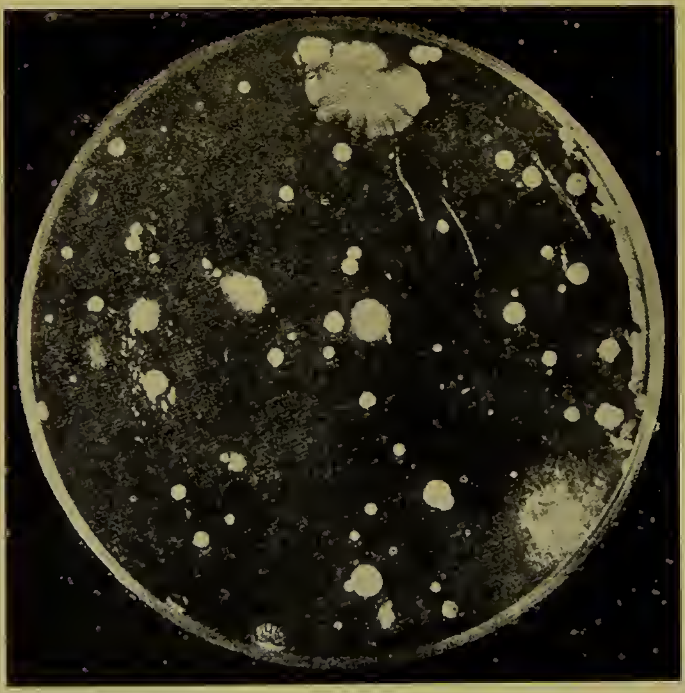


Fig. 4.—82 Colonies

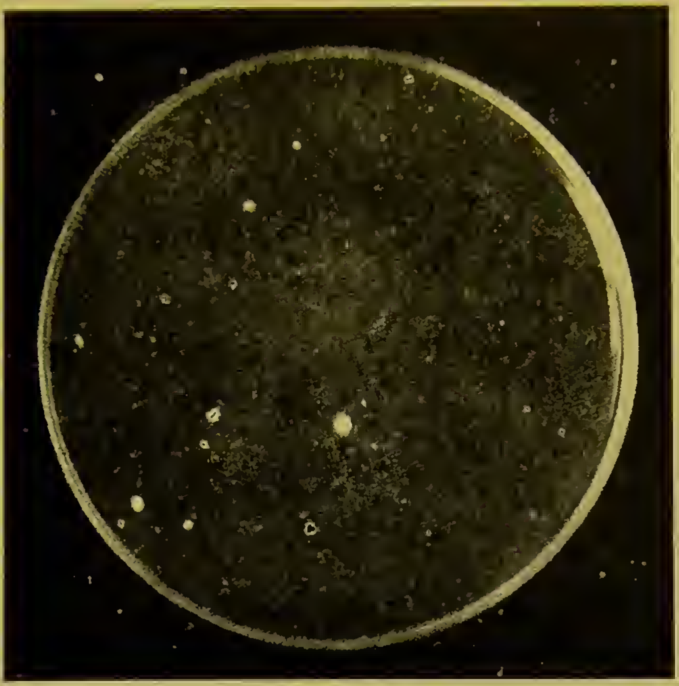


Fig. 5.—6 Colonies

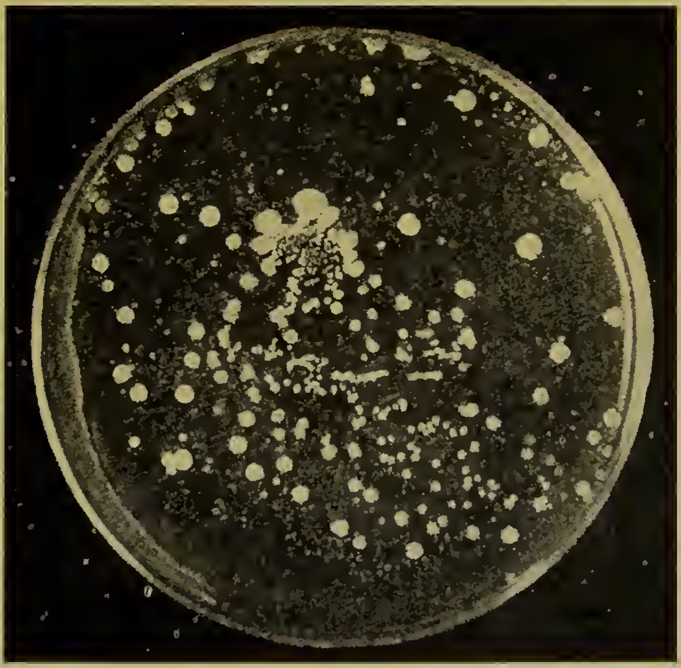


Fig. 6.—Innumerable Colonies

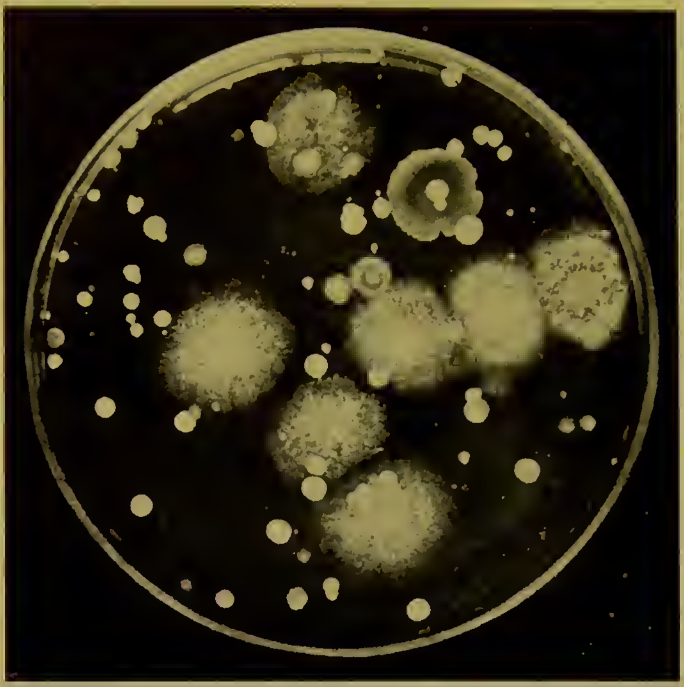


Fig. 7.—82 Colonies.

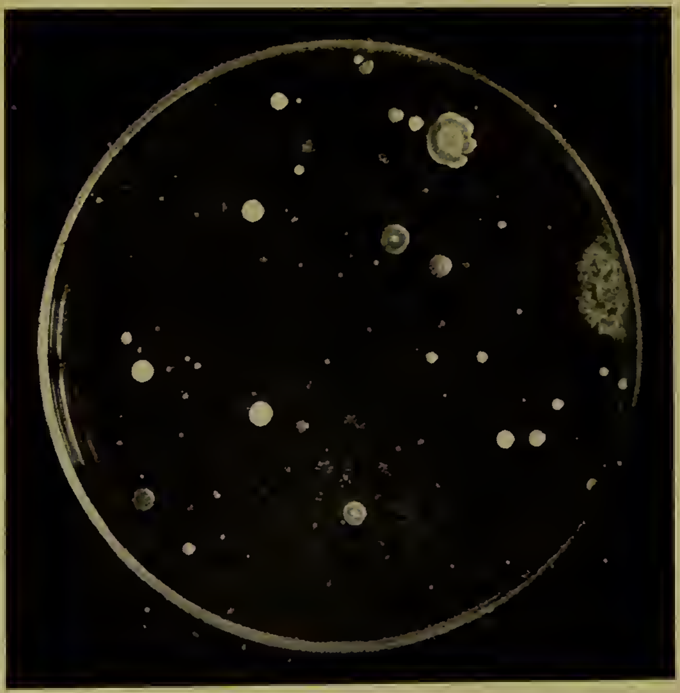


Fig. 8.—34 Colonies.

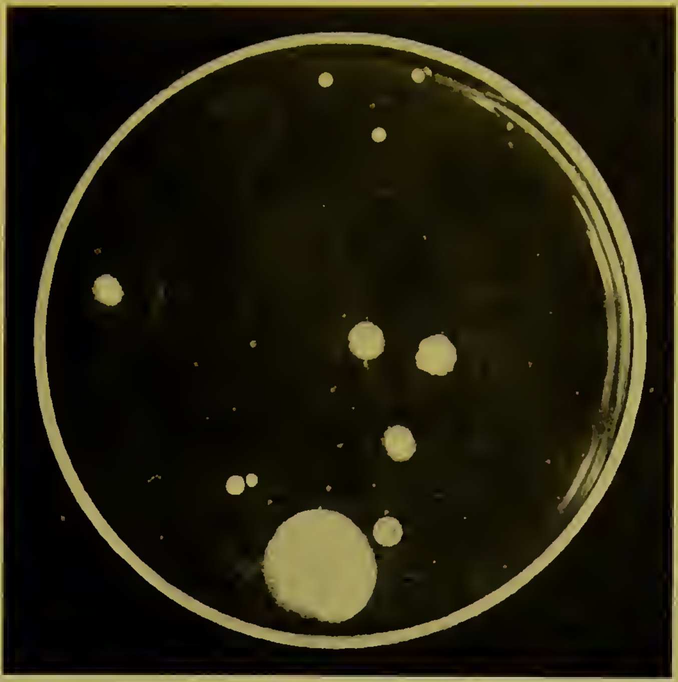


Fig. 9.—13 Colonies.

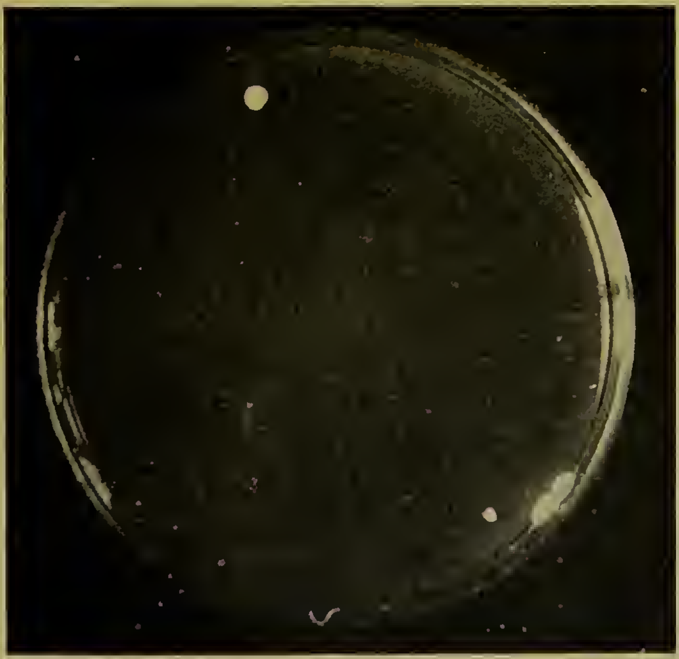


Fig. 10.—4 Colonies

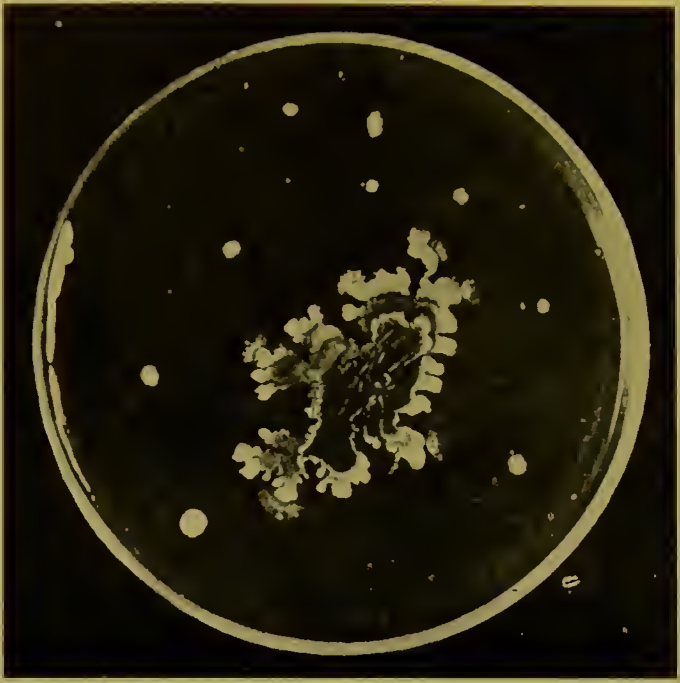


FIG. 11.—22 COLONIES

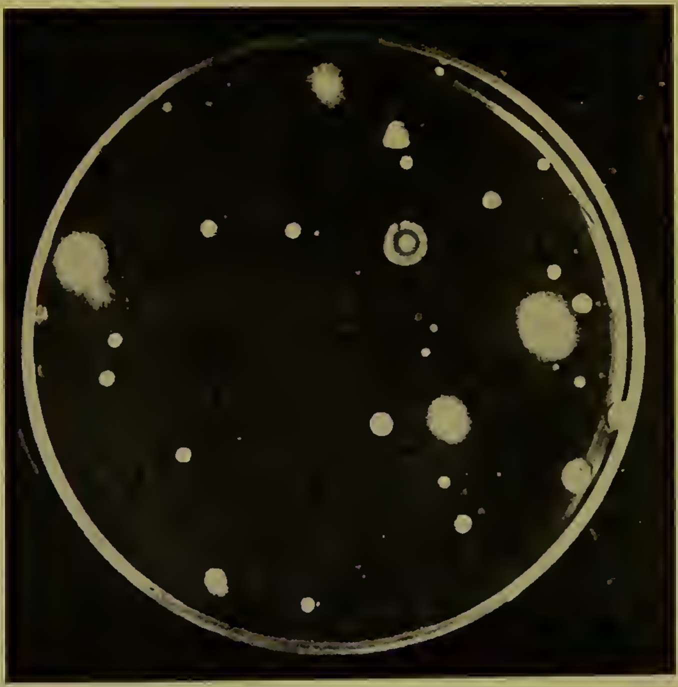


FIG. 12.—37 COLONIES

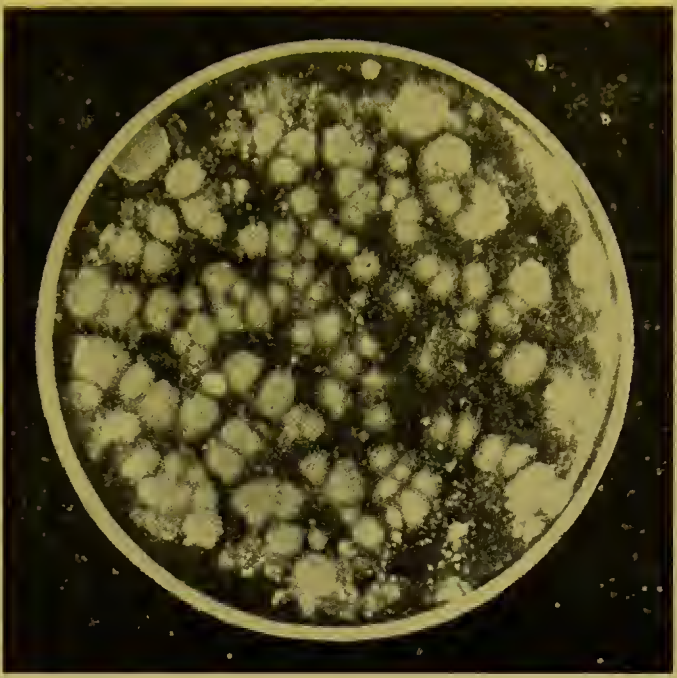


FIG. 13.—INNUMERABLE COLONIES

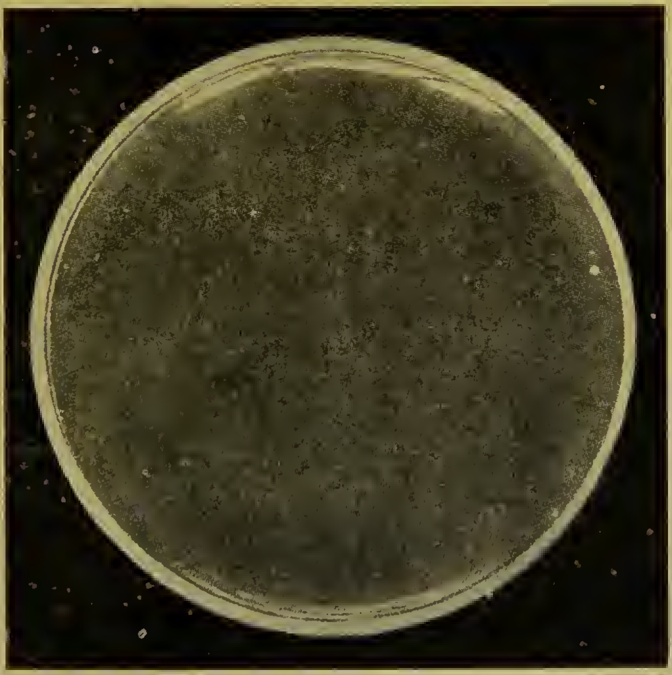


FIG. 14.—1 COLONY

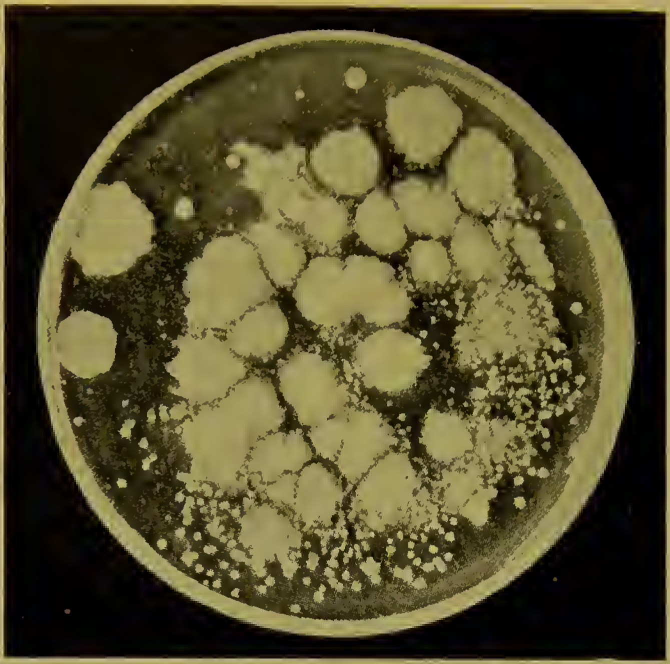


FIG. 15.—34 COLONIES PSEUDO-ANTHRAX; 120–150 COLONIES BACT. COLI.

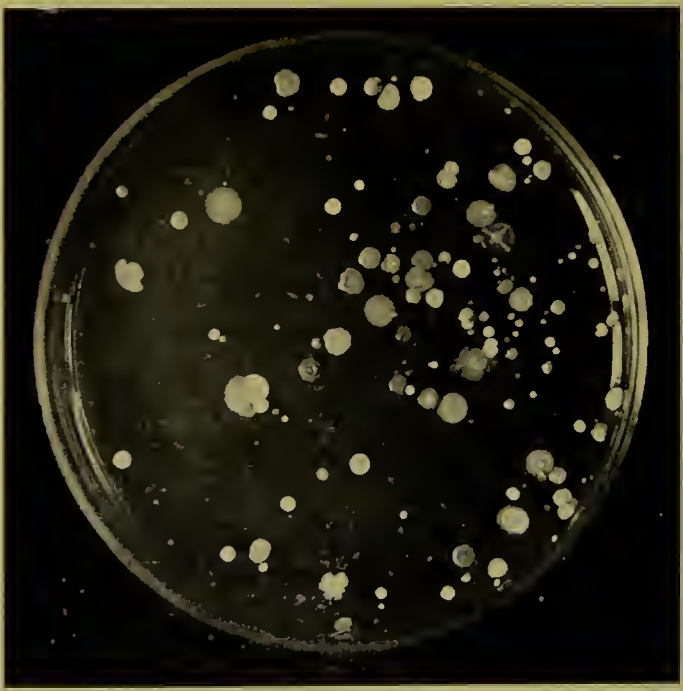


FIG. 16.—137 COLONIES

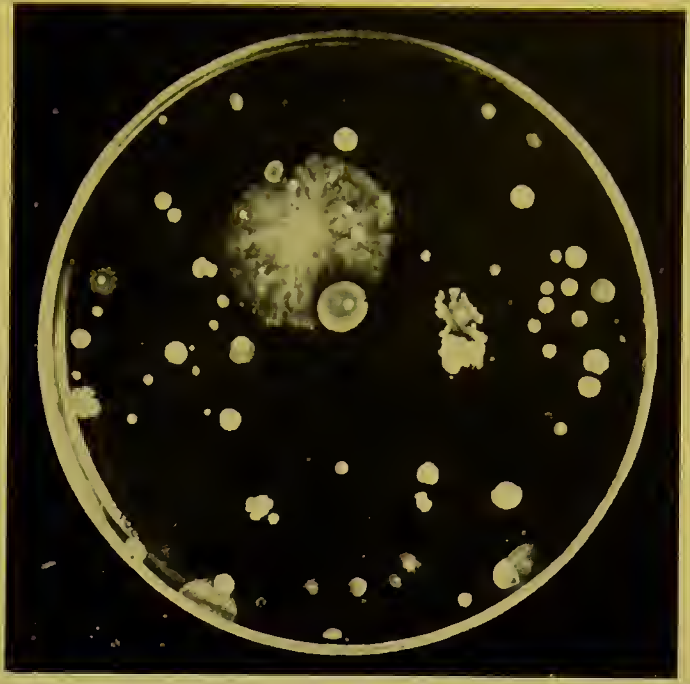


FIG. 17.—83 COLONIES

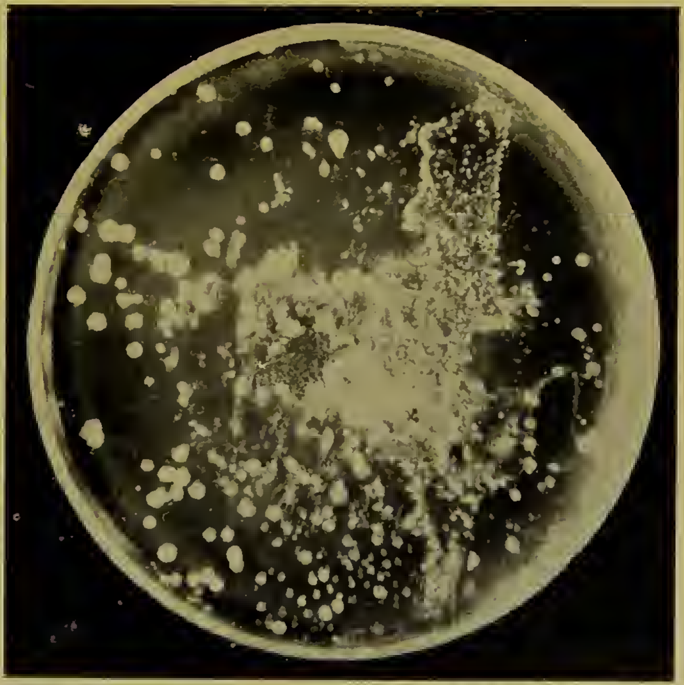


FIG. 18.—161 SINGLE COLONIES, AND MANY SMALL ONES

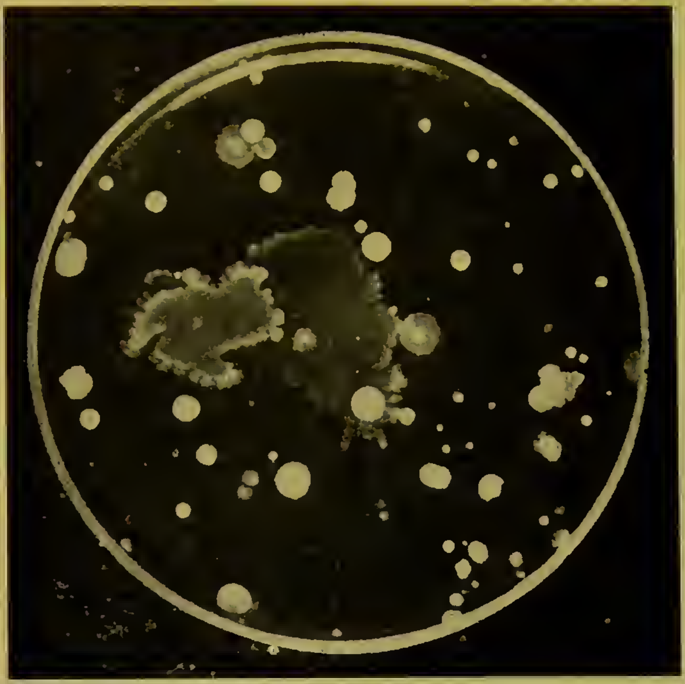


FIG. 19.—81 SINGLE COLONIES

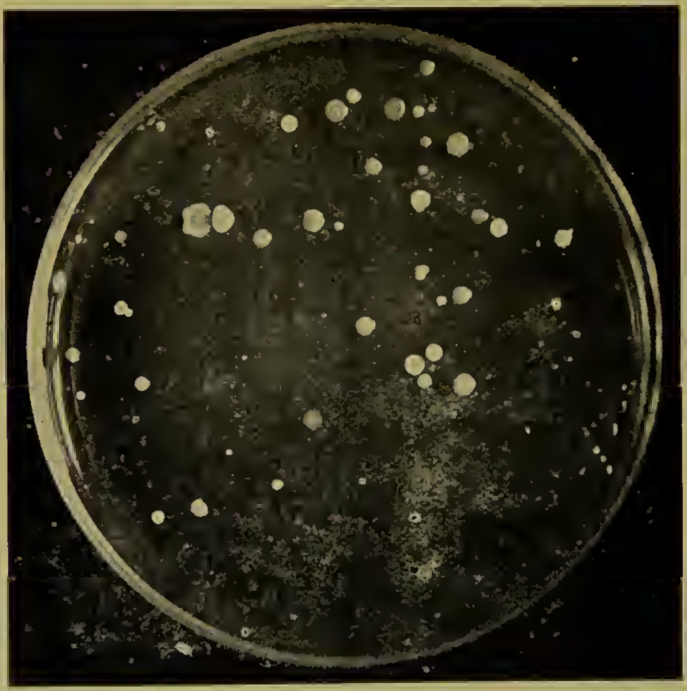


FIG. 20.—46 COLONIES

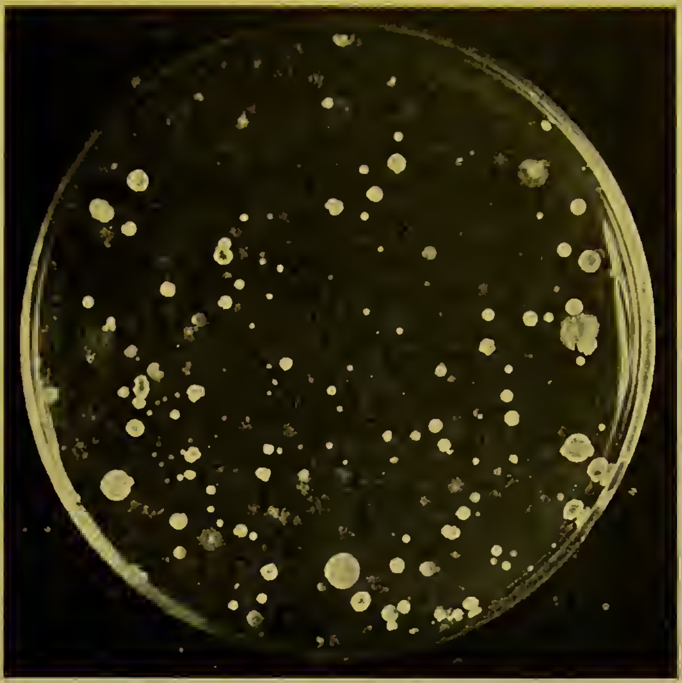


FIG. 21.—181 COLONIES

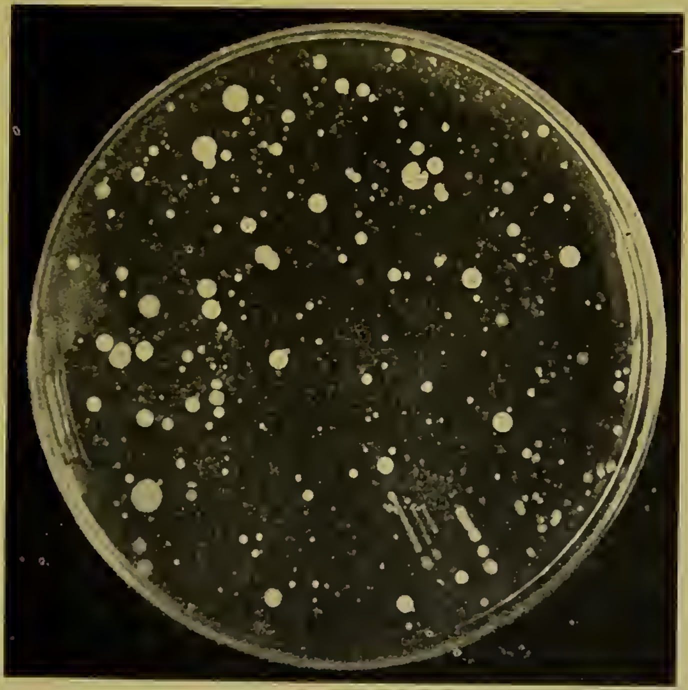


FIG. 22.—740 COLONIES IN HALF-CUBIC CENTIMETRE OF DRIPPING WATER

CHAPTER IX

BY-PRODUCTS

It is impossible to frame a definition of what is included under the term "by-products" that will be of universal application. In the United States—the country of giant packing-houses—every product of the abattoirs that is not dressed meat is classed as "offal," even sweetbreads. In Australia and New Zealand, the hearts, livers, &c., of sheep, which in this country are sold along with meat as food, aggregate into such large totals that the only way devised hitherto of utilising them is to extract the fat as tallow, and dry and pulverise the residue into fertiliser.

For the purposes of this chapter it will be sufficient to say that we classify as by-products everything from the abattoirs and purveyors' shops that may not be sold directly as food. The following is a list of the materials which come under this definition, and the whole of them require to pass through some special preparation or manufacturing process before they can be sold for food or other purposes.

Fat.
Bones.
Hoofs and horns.
Blood.
Entrails.
Hair and bristles.
Condemned carcases.

In one sense, hides and wool come under our definition of by-products, but their true position is that of serving as the raw materials of very important industries, and regarded in that way they are anything but by-products.

Heads and feet are usually classed as offal, but in this country the meat they afford is sold as such, or in the case of heads it may be used for sausage-making, which is treated of elsewhere. Feet, however, are also subjected to some manufacturing process, of which mention will be made. The bones yielded in either case are treated in the same manner as other bones.

The general procedure followed is to indicate first the methods by which the by-products may be manufactured into food materials, because, as a rule, better prices can be obtained for them when so utilised than when turned to other purposes.

Small Quantities. Perhaps a few remarks on the methods of working up small quantities of by-products may be of interest, in view of the fact that meat-purveyors very seldom make any efforts in that direction. The by-products of the shop are chiefly bones and rough fat. The usual practice is to store these materials up and hand them over in a highly smelling state, and at a very low price, to the carts of the tallow-melters and manure-manufacturers on their periodical rounds. A far better plan is to get a green bone-cutter and grind the bones into a fine meal. This machine (Fig. 1) consists essentially of a rotary cutting tool of special design, fixed at the bottom of a case for holding the bones, with an arrangement for continuously thrusting the bones against the cutter. It is made in all sizes both for hand and power.

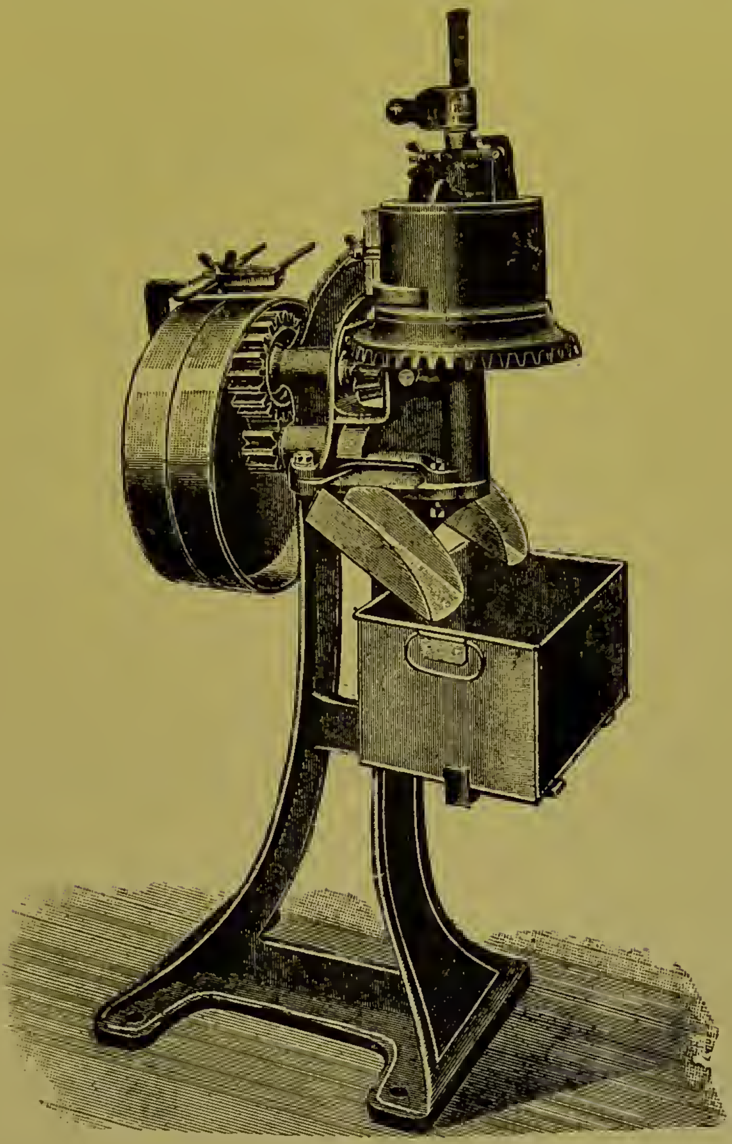


Fig. 1.—"Green" Bone Cutter

The meal made from fresh "green" bones, with all the fat in, is a valuable food for poultry, and fetches good prices. Should there not be a local demand for poultry foods, the bones may still be ground and the meal boiled in water to extract the fat, which can be sold for cooking purposes. The water should be sieved from the residual bone-meal, and the latter dried in any warm place. It can then be supplied to horticulturists and amateur gardeners at four times the price obtained for bones in the ordinary way.

Another method is to place the ground bones in the "cage" of a digester (Fig. 2) lined with felt or clean sacking. Some water is placed in the digester, the cage is placed in position, the lid screwed up tight, and heat applied, preferably by a gas-ring. The pressure is allowed to go up to, say, 40 lb., as shown by the gauge on top, and maintained at this for three or four hours. We then obtain in the bottom of the digester the fat and a strong solution of gelatine, which is very useful for brawn-making, &c. The residual bone-meal can be dried and sold as stated. Larger bone-digesters may be heated with steam brought in by a pipe in the side.

Fat can be rendered down and disposed of in the same way as fat from bones. As colour is not important, the rendering may be done in a pan over a fire. The brownish tint that is apt to result from this treatment is an advantage rather than otherwise, for the fat then passes as dripping. Care must be taken to filter the fat so that it is free from fibre, and it will then keep for a considerable time. The fat and bones must be kept quite fresh, either by storing in the cold-room or by pickling in brine. Where gelatine solution is to be made, or fat rendered, the brine must be got rid of by steeping several times in fresh water, but where the bone-meal is boiled, this is not necessary as the water carries off the salt.

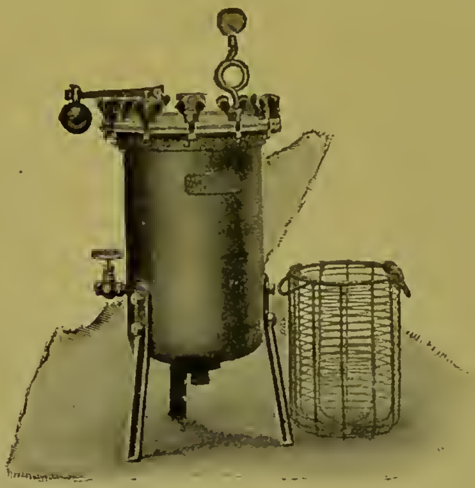


FIG. 2.—SMALL-BONE DIGESTER

The Importance of Fat. Excluding hides, the most important abattoir by-product is the fat trimmed from the intestines and other internal organs of cattle. The rest of the fat of the carcase is passed on to the purveyors as part of the dressed meat; as we have seen, some of it is sent by them to the tallow-renderers, not much of it being fresh enough to be worked up into food-products. The most direct method of working up the "cattle-killing fat" is to turn it into rendered suet, and this is now done on a considerable scale. To produce a fat that will keep, it is necessary that the raw material should undergo immediate treatment, and the works are usually situated close to the abattoirs. The fat is taken away as soon as it is trimmed off, and the parts suitable for the purpose are selected, washed well in chilled water, and carefully rendered in steam-jacketed pans, filtered and run into moulds, and then packed into cartels or other packages for sale. It is sold by grocers and others as "beef suet." Treated in this way the fat keeps good for many months.

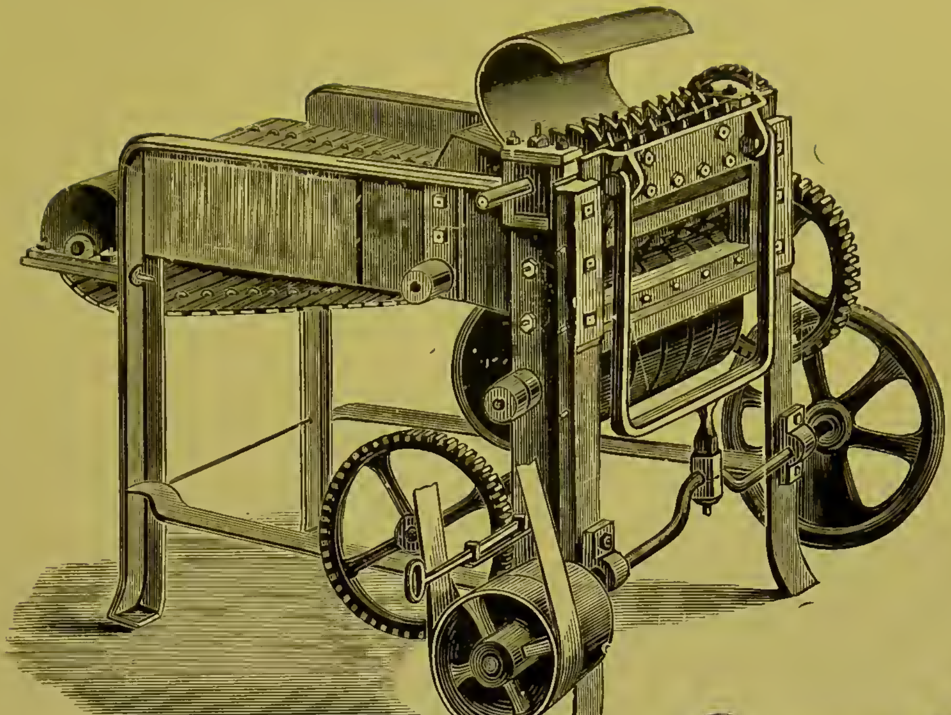


Fig. 3.—Fat-hasher

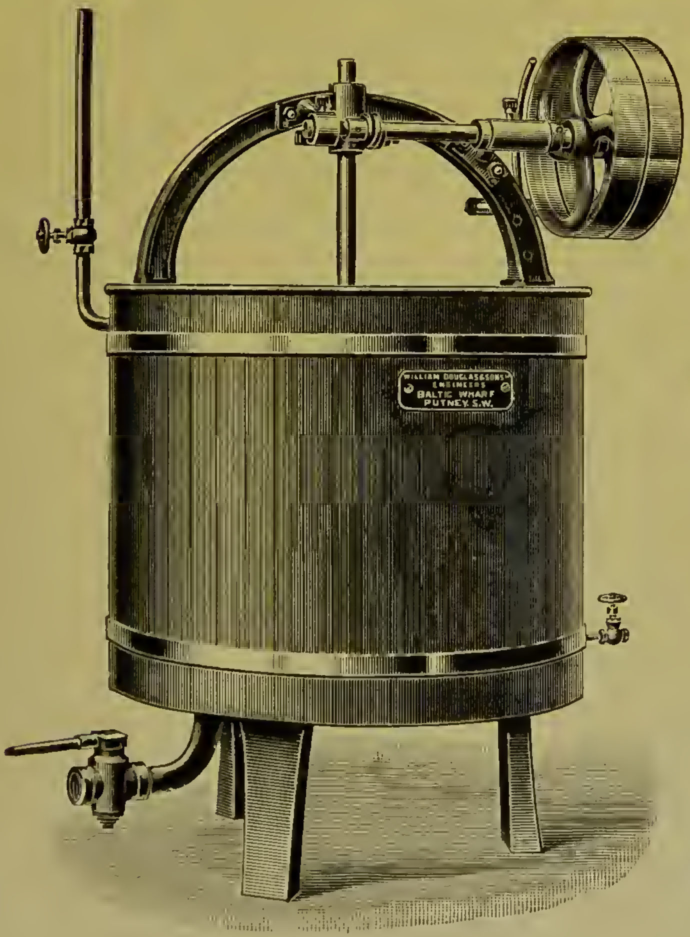


Fig. 4.—Oleo Rendering-pan

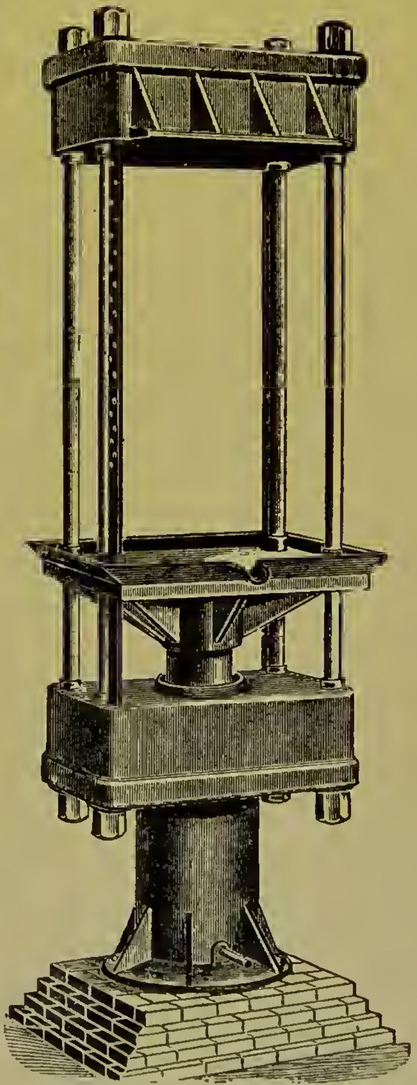


Fig. 5.—Hydraulic Press

Of late years the product has been made into a granular form by the aid of powerful machinery, which facilitates its use in the household.

By far the greater part of the fresh beef-fat, however, is manufactured into "oleo" and "stearine," and it is even more important in this case that the raw material should be perfectly fresh when subjected to treatment. Oleo must be neutral, and the crude fat, if kept in that condition, soon begins to develop acidity. The grades it is sorted into vary—some manufacturers have two qualities of oleo and others half a dozen. After washing in chilled water, the fat is cut up in a "hasher" (Fig. 3).

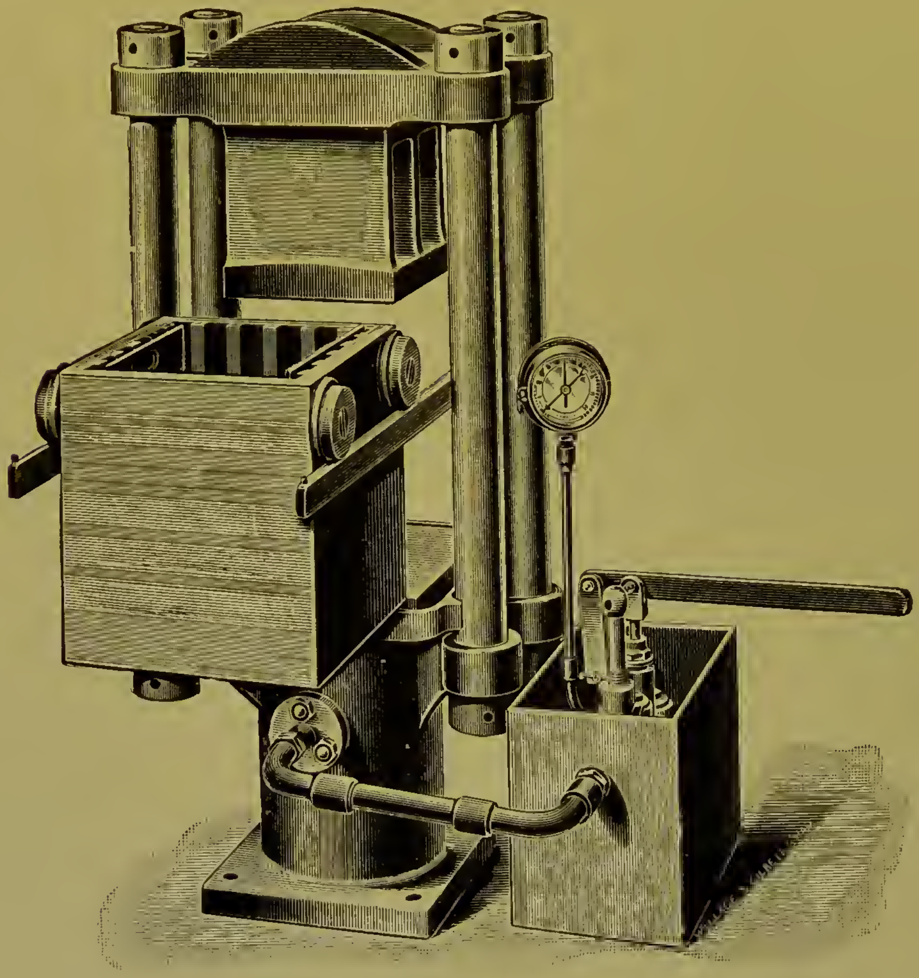


Fig. 6.—Hydraulic Box Press for "Greaves"

It is then transferred to an oleo rendering-pan (Fig. 4), consisting of a steam-jacketed iron vessel (sometimes of cast-iron, but now generally made of wrought plates) with an agitating gear, which stirs up the fat and keeps the temperature of the mass uniform. High temperatures develop acidity, so that it is very important to secure regulation and uniformity. The temperature should not exceed 180° Fahr. The first runnings or "premier-jus" yield the best oleo.

After filtering or settling, the rendered fat is cast into wooden moulds, of a size to suit the plates of the hydraulic press described below. The moulds are allowed to cool in a room kept at a temperature of 80° Fahr.

Each cake of fat is then wrapped in a press cloth of special strong substance and packed into the hydraulic press (Fig. 5), with a steel plate between every cake and the next one, until the press is full. Pressure is then applied, and the press-room being maintained also at 80° Fahr., the oleo runs off in an oily condition. The residue in the press is stearine, which is used for soap- and candle-making, and also, to some extent, is mixed with cooking-fats to harden them. Oleo is the basis of margarine, which is now manufactured on an enormous scale.

We cannot treat of the margarine process in detail, but its main points may be indicated. Oleo with refined cotton-seed, nut, sesame and other oils, which go to make up margarine, are melted together and emulsified with milk, in a special machine for the purpose. The mixture is then churned exactly like cream, annatto or other butter-colouring being added. The butterine is worked up on circular blending-tables like butter, and packed in bags, boxes, &c., for the market.

Returning to the oleo-rendering pan, the residue is pressed in box-presses, which may be on either the screw or the hydraulic principle and fitted for hand or power.

Fig. 6 shows a hand-power hydraulic box-press.

The residual cake is known as "greaves," and is sold for making dog-biscuits or, in the powdered state, as game- and poultry-food, &c. The fat which is unfit for making into rendered suet or oleo, goes to the tallow renderers, who also work it up in steam-jacketed pans—but in a rougher way—into tallow for soap- and candle-making, and a number of subsidiary purposes. Tallow-rendering is a disagreeable business; the fat is frequently in a semi-putrid state, and emits very noxious gases and fumes during the process. To meet the requirements of the Acts administered by the sanitary authorities, these gases and fumes must be passed through a tower, where they are washed with water and then burnt in a fire (usually a boiler fire) before being passed into the atmosphere.

Hard soaps are made by boiling tallow and other fats and fatty acids with certain proportions of caustic soda-lye. After a time a uniform solution of soap is obtained, and to this salt is added, which separates the soap from the solution. It is then cast into moulds, made of sections screwed together. When set, the soap is cut into bars with wires, and is then ready for the market. Soft soap is made with potash-lye, and it cannot be salted out, because, if salt is added, a transfer of the alkalies results and hard soda-soap separates. Consequently, soft soap is boiled down to a pasty condition, and sent into commerce in this form.

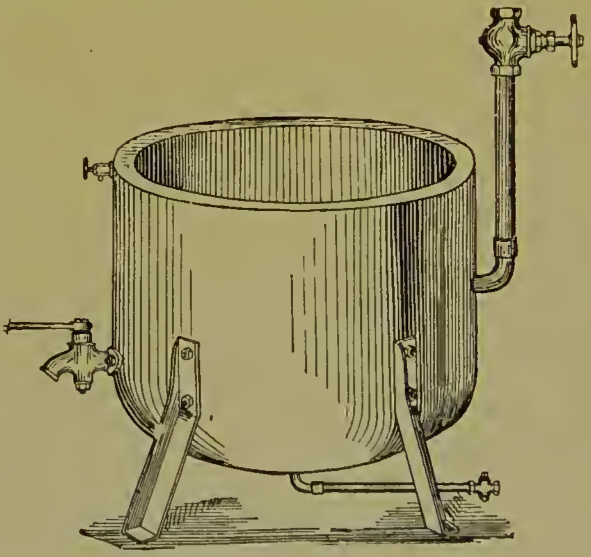


Fig. 7.—Steam-jacketed Pan, without Agitator, used for the rendering of fats

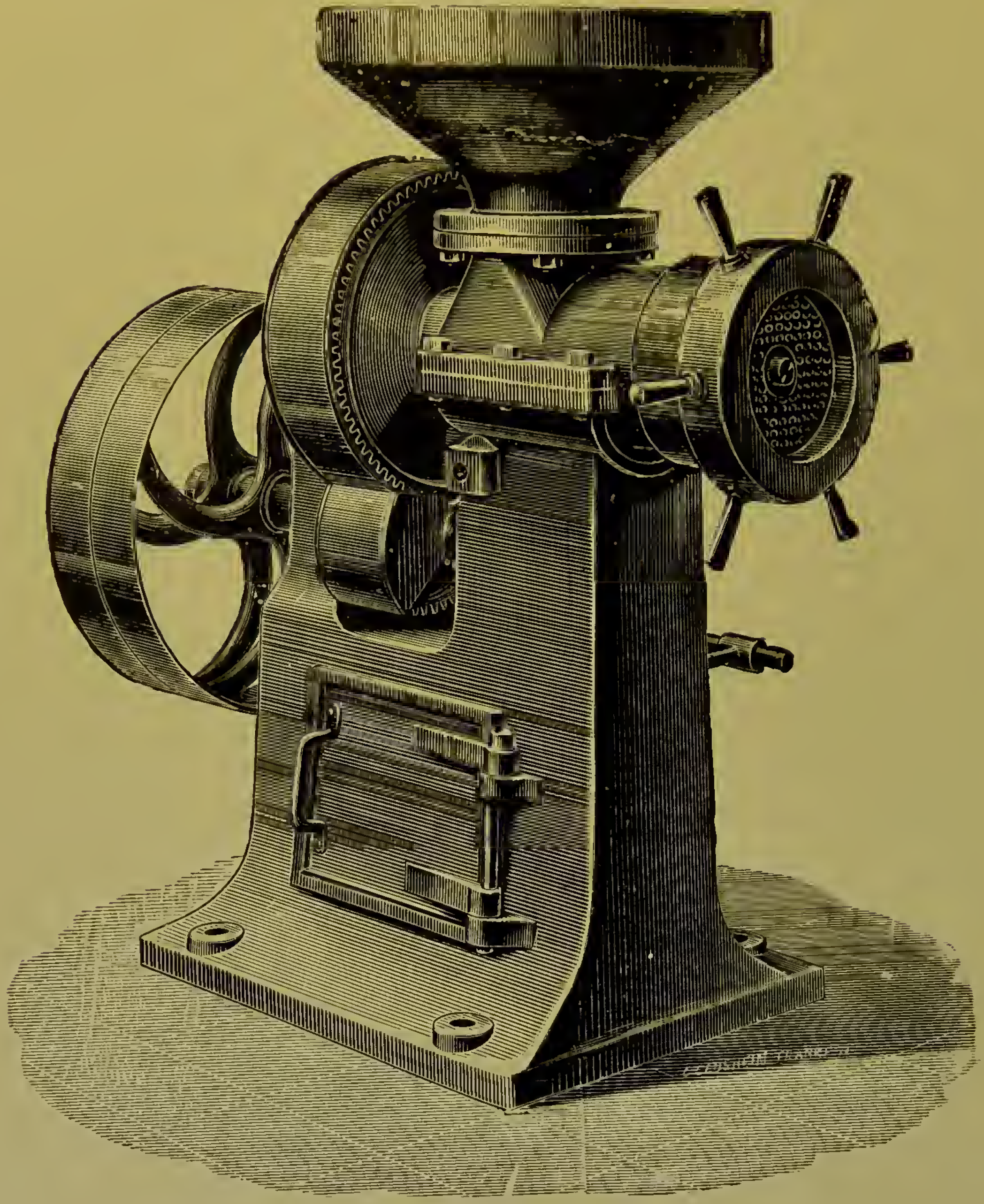
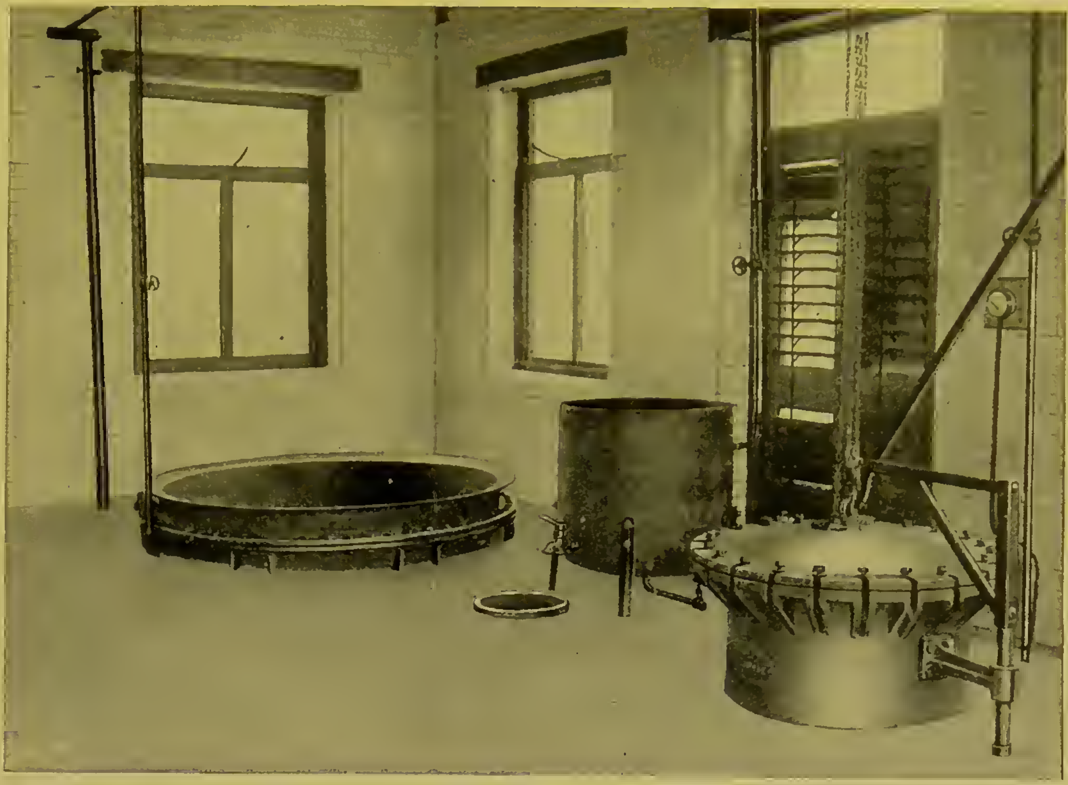


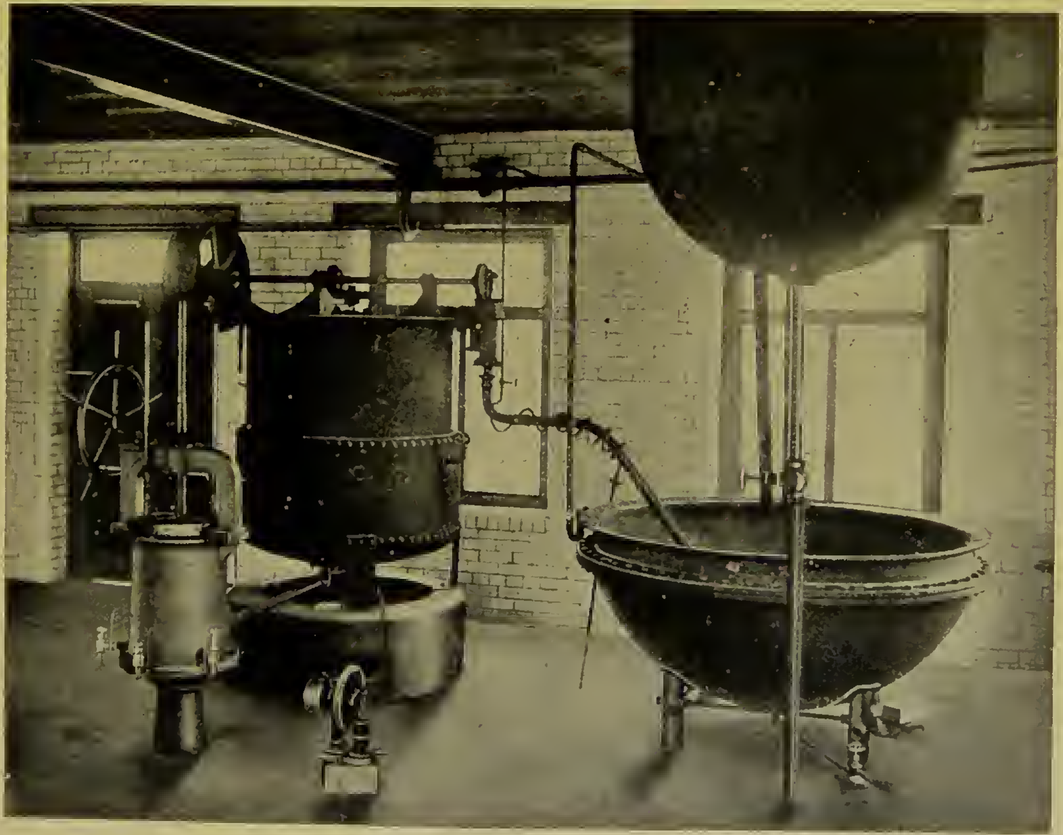
Fig. 8.—Fat-cutter

Milled, scented, and other refined soaps, are made from a basis of good tallow-soap by shredding and mixing with perfumes, colours, &c., milling and moulding, solution in alcohol, &c.

In the manufacture of candles the rendered tallow is mixed with a proportion of strong vitriol, and then distilled in a current of superheated steam. By this process the fat is decomposed into glycerine and oleic, palmitic and stearic acids. The glycerine is either refined or sold in the crude state, and is used for a variety of purposes, most largely for making nitro-glycerine and other explosives. The mixture of fatty acids is submitted to pressure in the hydraulic press, first in the cold state, by which lard-oil, consisting chiefly of crude oleic acid, is obtained. Lard-oil is used for lubricating and other purposes. The residue is then pressed in a warm press and yields palmitic acid, which goes to the soap works. The hard cake left in the press is stearic acid, and is used for making



LARD-REFINING PLANT
Showing rendering-pan sunk in floor, auxiliary melting-pan and digester with crane or lid, sunk in floor.



LARD-REFINING PLANT
Showing refining-pan, lard-agitator and cold-lard filler.

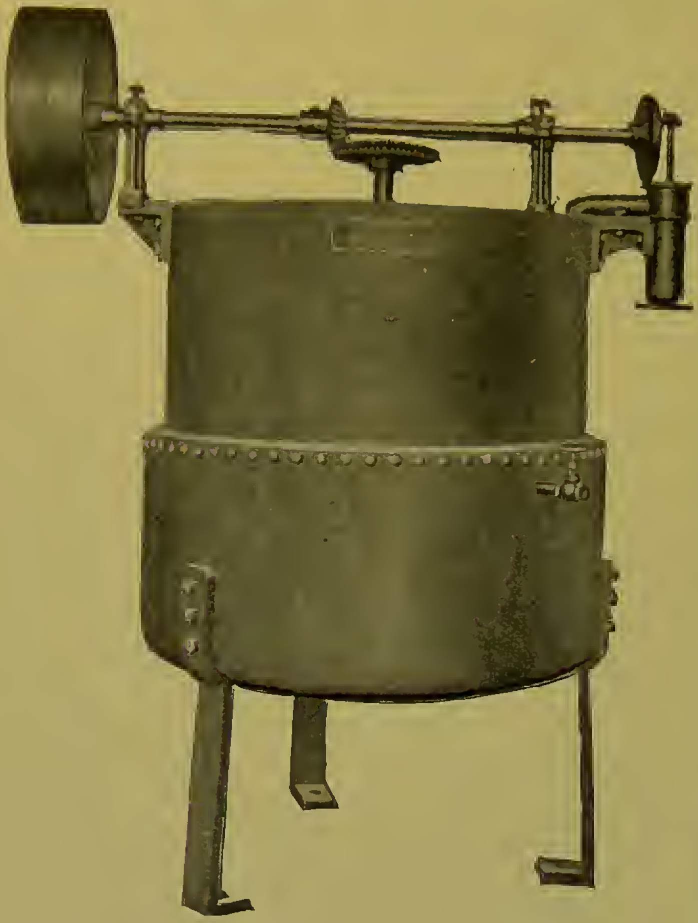


FIG. 9.—LARGE JACKETED PAN WITH AGITATING GEAR

stearine candles, or, blended with paraffin-wax, for making another variety of candle.

The surplus fat of pigs is worked up chiefly into various qualities of lard. It is more a product of the bacon factories, or the large American packing-houses handling hogs, than of the ordinary abattoir. The best qualities are rendered in steam-jacketed pans, usually without agitators. These pans (Fig. 7) may be of any capacity from 5 to 250 gallons. The latter size is preferred for large work. The pans can now be had all welded in one piece, which avoids the possible leakages about the rivets and seams, and also the annoyance caused by the knocking of the tools against the rivet-heads. They are mounted on iron legs and have the following fittings: Steam-valve, condensed water-cock, cock for running off lard, and air-cock to permit of the escape of the air in the jacket when the steam is first turned on. The jacket, or the space between the inner and outer shells for the accommodation of the steam, is usually about two inches in width.

The first process is the cutting of the fat into small pieces, and Fig. 8 shows a machine much used for this purpose.

It is constructed on the principle of the "Enterprise" sausage-meat cutter, with an

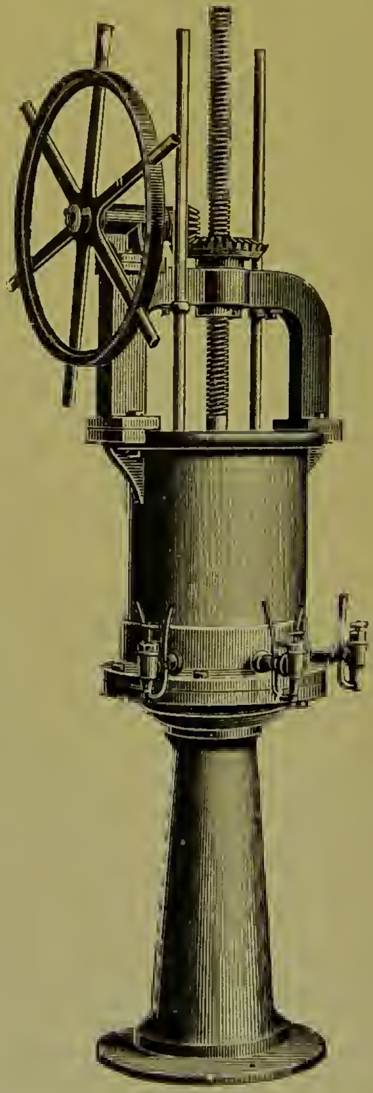


FIG. 10.—COLD-LARD FILLER

archimedean propeller, rotating four branched knives, and fixed perforated plates with large square holes.

After the fat is rendered, the residue is pressed in a screw-press, the greaves left being used similarly to that produced from cattle-fat, but a small proportion is retailed for human food as "cracklings."

In the United Kingdom lard used to be packed mostly in bladders, and a good deal is still put up in that way. For this purpose on the large scale special machinery is employed; the rendered lard is pumped into a large jacketed pan (Fig. 9) with agitating gear. Cold water is circulated in the jacket while the lard is agitated by the stirrers. When it becomes pasty, it is drawn off into a lard-filling machine (Fig. 10) which is connected to the bottom of the agitator by a wide pipe. The filling machine consists of a cylinder with piston and gear to raise and lower it, and round the bottom of the cylinder is a series of filling-cocks. The upward stroke of the piston draws the lard from the agitator into the cylinder, and the supply-pipe is then closed by a cock for the purpose. The filling-cocks are on the plug principle; bladders are fixed to the nozzles of the plugs and held in position by spring catches. The plugs are then drawn up, the piston driven down, and the lard is forced into the bladders. As each is filled the plug is pushed home, the bladder removed, and a fresh one substituted.

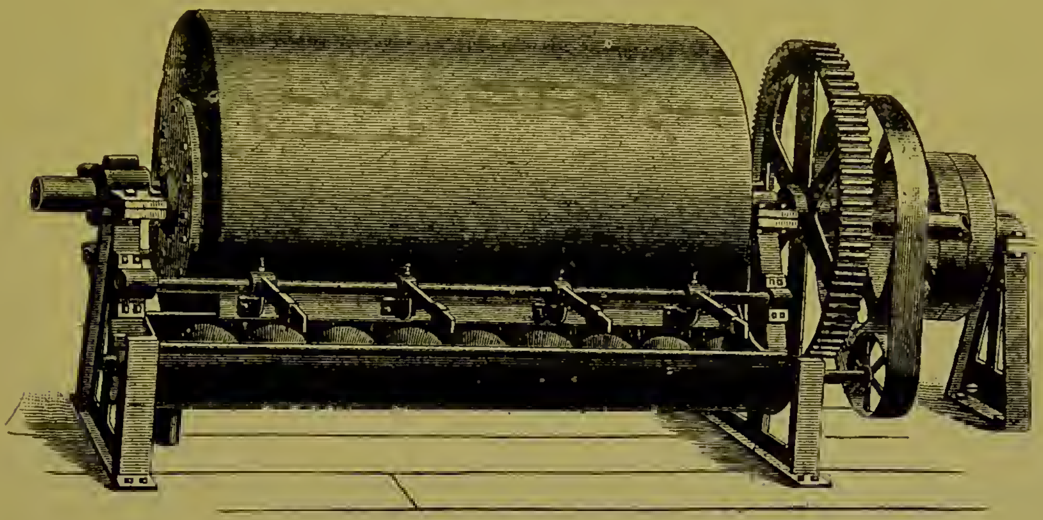
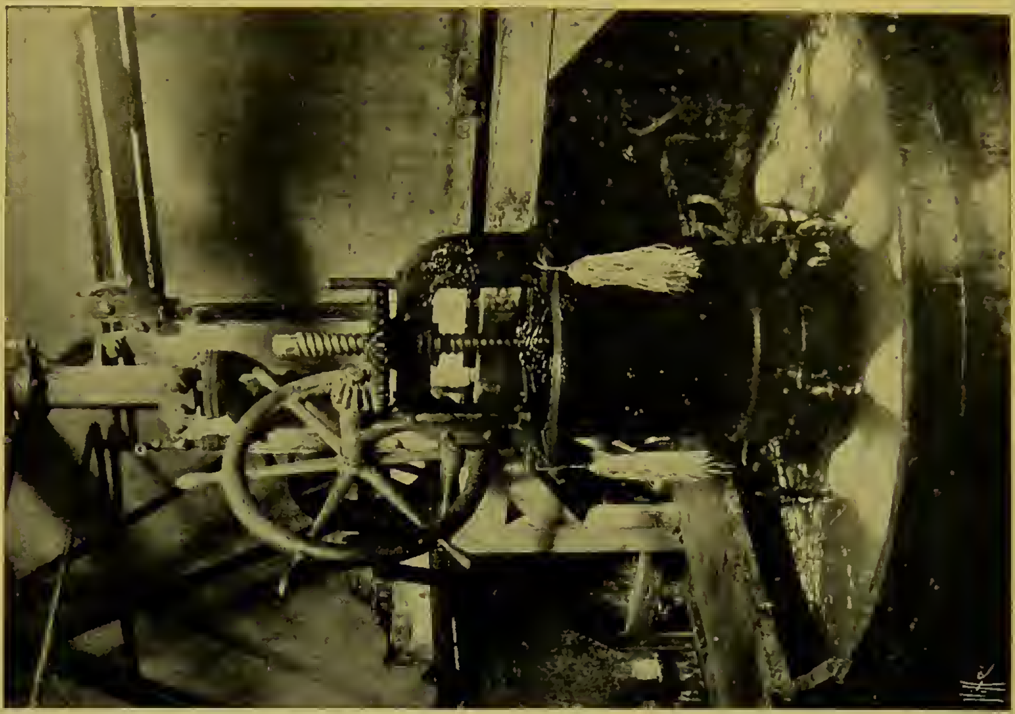
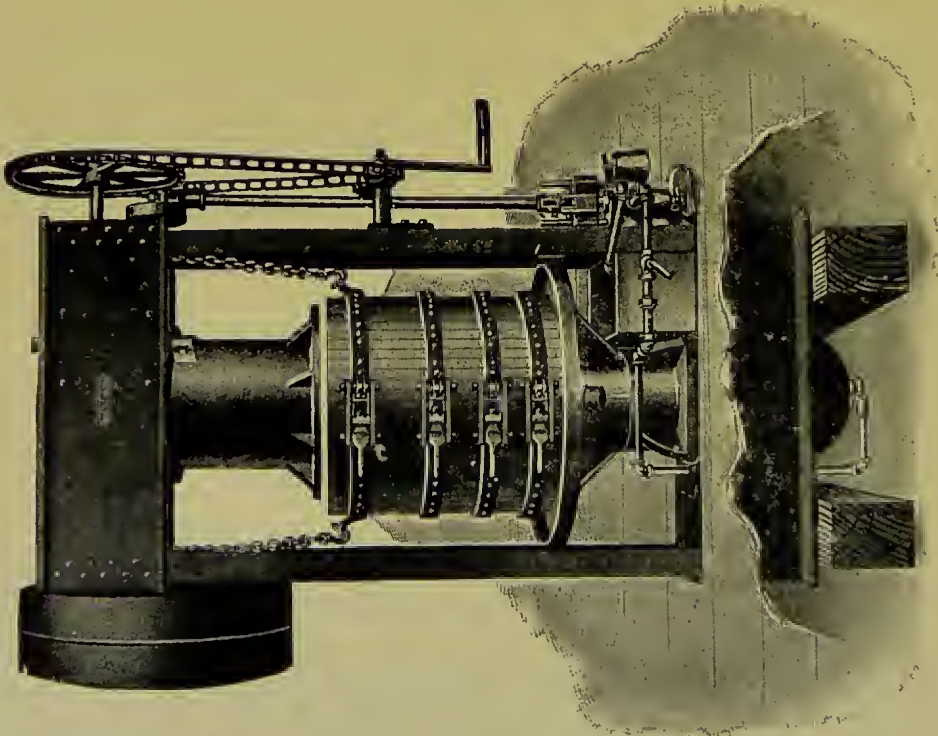


Fig. 11.—Lard-chilling Cylinder

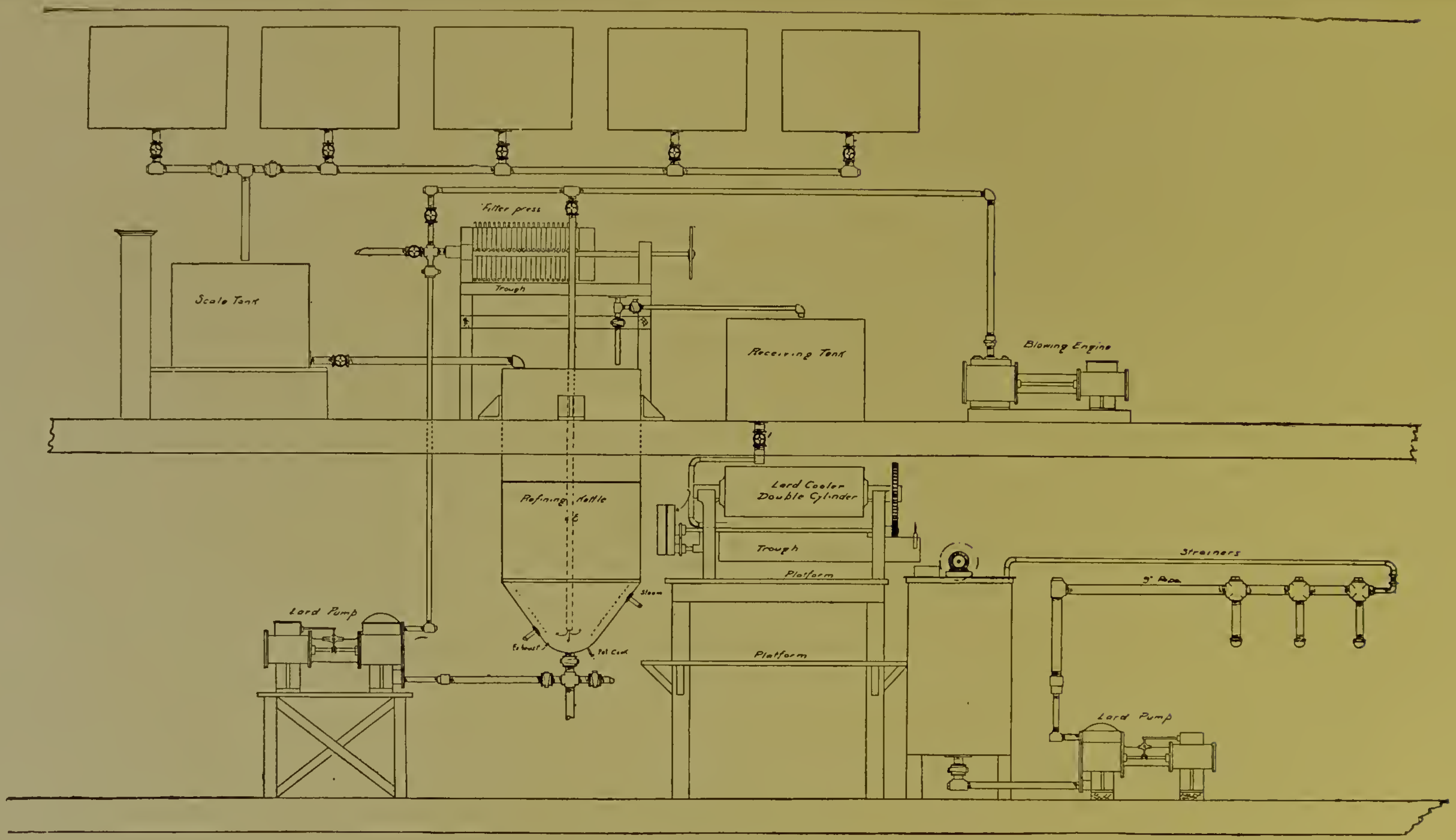
The preliminary cooling in the agitator is a matter of some importance; when lard is allowed to cool slowly, crystals of stearine are formed, and the product lacks the smooth, white, uniform appearance it presents when quickly cooled. A further development in this direction is cooling by refrigeration, and Fig. 11 illustrates a machine for the purpose. It consists of a revolving cylinder cooled by an internal circulation of cold brine from a refrigerating plant. The cylinder dips into a tray kept fed with melted lard, and as it revolves the cylinder picks up a film which is chilled on the way round. A knife pressed against the cylinder, on the further side, scrapes off the chilled lard, which falls into a suitable



Cold-lard Filler in Use



Hydraulic Lard and Grease Curb Press



Lard-refining Plant

Consisting of store-tanks, scale-tank, refining-kettle, lard-pumps, filter-press, receiving-tank, lard-cooling cylinder, cooling-tank and blowing-engine.

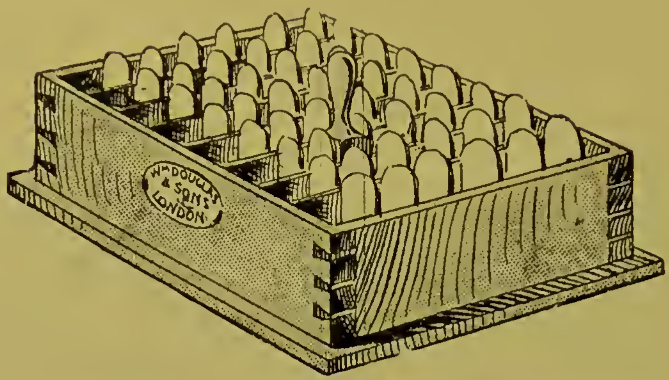


Fig. 12.—Lard-blocking Frame for Moulding Square Parchment Packages

receptacle underneath, from which it is taken to be packed into pails, boxes, &c.

A good deal of lard is now put up in parchment-paper bags by the aid of the lard-blocking frame (Fig. 12) made of wood, with fixed divisions in the one direction and movable slides placed in grooves in the other, the spaces formed being of certain exact sizes according as the bags to be filled are of $\frac{1}{4}$-lb., $\frac{1}{2}$-lb., 1 lb. or other sizes.

The bags are stretched on a piece of wood of square section and of the right size for the divisions. After being placed in position the bags are filled with melted lard, allowed to cool, and then made up and packed in boxes. This method of packing is cheap, compact, neat and effective.

Mutton-fat is rendered in the same way as beef-fat and lard. It is a good deal harder, containing a larger proportion of stearine than the others. This makes it useful for forming a preservative layer on the top of packages of meat-pastes, &c. It is also to some extent made into oleo, but its peculiar flavour, derived from the presence of capric acid, prevents it from being very extensively worked up into food products, but now there is a large demand for mutton oleo, especially from the Continent of Europe.

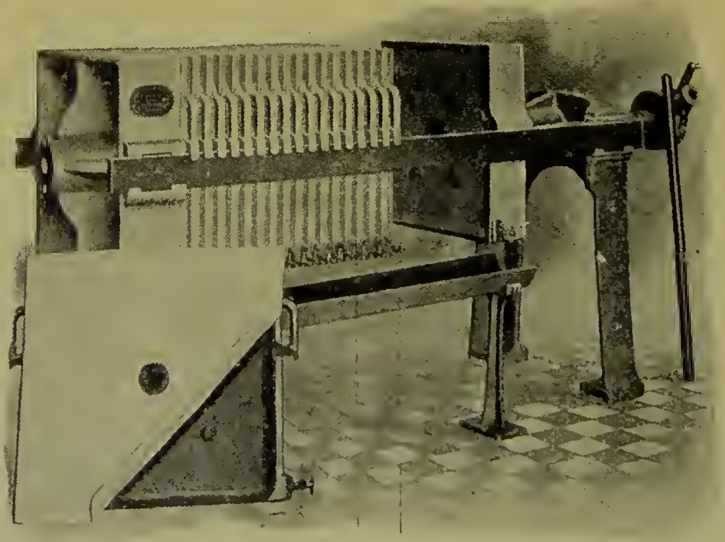


Fig. 13.—Filter-press

Inferior fats may be much improved by refining; they are bleached by treatment with fuller's earth, and if disagreeable odours or taints are to be removed this can be accomplished by the addition of bone charcoal. The fat is melted in a steam-jacketed pan fitted with agitating gear, and the fuller's earth and charcoal are added in proportions varying with the quality of the fat, and the whole agitated for a varying time—usually twelve to fifteen minutes, the temperature of the fat also varying from 180° Fahr. downwards. All these points can only be determined by experience. The mixture is then run through a filter-press (Fig. 13) having a series of compartments formed of recessed plates, with filter-cloths in each. The fat is pumped into the compartments through a central tube, is forced through the filter-cloths, while the fuller's earth and charcoal are left in the compartments in the form of cakes, which are afterwards boiled to remove the fat retained, this fat being of inferior quality. The filtered fat which comes from the press should be white and odourless.

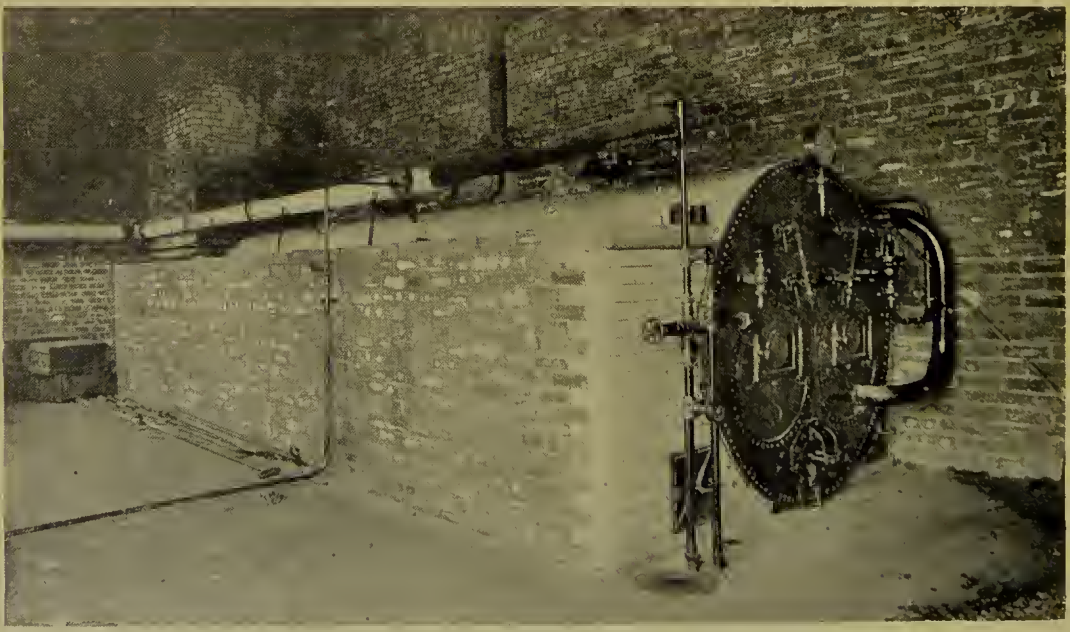
Blood-drying Plant: General View of the Buildings

A special oil called "neat's-foot oil" is extracted from the feet of cattle, and forms a valuable lubricant for delicate machinery. The feet are first washed in cold water to remove blood, &c., then scalded in water at about 170° Fahr. to loosen the hair and permit of its being scraped off. The feet are now immersed in boiling water for fifteen minutes, when the claws or hoofs are loosened and can be removed and the feet split. Prolonged cooking in water and then settling, yields the oil as a layer on top. It is skimmed off and filtered.

The Treatment of Blood. In the chapter on sausages, the manufacture of black or blood puddings is dealt with. It is an extensive industry, especially in the Midlands of England. In different countries blood is utilised in many different ways, as, for example, in Sweden, where there is a kind of meal produced from a mixture of blood, flour and chopped fish, which is dried and used in cookery.

General View of the Serum-drying Room

Many attempts have been made to use blood as a food for animals, and in different parts of the Continent it is compounded with treacle and milling offals, and fed successfully to pigs, horses, poultry, &c. Blood is also used to some extent in dyeing. A very large surplus remains at present, however, after these demands have been satisfied, and a proportion of this is treated for the separation of albumen. The blood of cattle as it flows from the animals is received in flat tin trays, and is allowed to stand for an hour till it coagulates, when it is cut into cubes and transferred to galvanised sieves about 2 ft. square, the bottoms of which are covered with $\frac{1}{8}$-in. mesh wire-cloth. The sieves are placed on flat galvanised trays, and the albumen drains through into these. The first runnings are red and of inferior quality, and are worked up into



Steam Boiler in Blood-drying Works at Glasgow

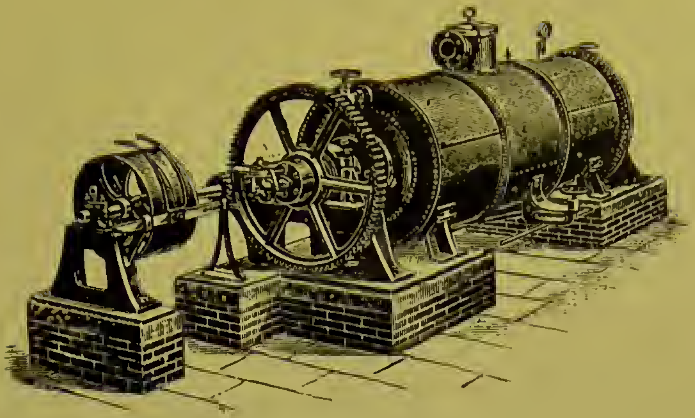


FIG. 14.—HORIZONTAL BLOOD-DRIER

cheap albumen used in sugar-refineries for clarifying purposes. The clear yellow albumen which comes next is allowed to settle for a night and then syphoned carefully off so as to avoid impurities. It is run on to glazed earthenware plates to a depth of $\frac{1}{8}$ in. or less, and the plates are packed in racks in a drying-room, where a circulation of hot air, not exceeding 120° Fahr., is maintained. The albumen dries up into films, which are then ready to put into market packages. Blood-albumen is used a good deal in dyeing as a mordant, and to some extent in foods and as "finings" for liquors. The demand and the price vary a good deal, and it is not always a profitable article to manufacture.

The clotted-blood residue from albumen-making is dried into a powder, which is used as a fertiliser and to a small extent as a poultry food. A large proportion of the blood produced is worked up in the same way, without the previous treatment for the extraction of albumen. The apparatus most frequently used for this is the circular drier (Fig. 14).

It is made up of a steam-jacketed cylinder containing a shaft, mounted with arms, having scrapers to keep the inner surface clear and to continually agitate and mix the blood, so as to facilitate the escape of moisture in the form of steam. There is a man-hole on the top for charging in the blood, and another on the bottom for drawing off the dried material. A fan removes the steam and gases, which are usually passed through a

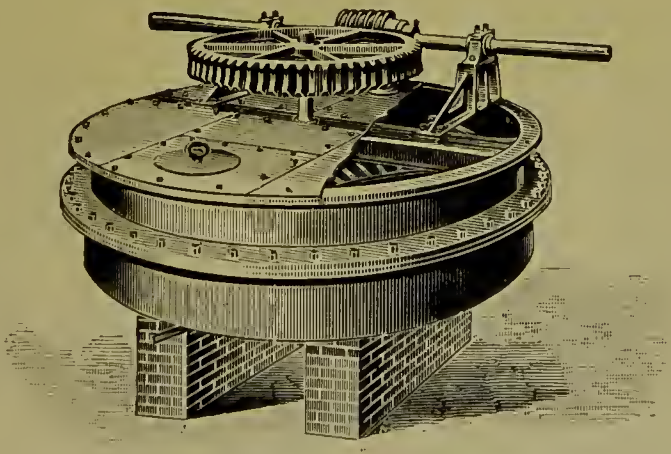


FIG. 15.—VERTICAL BLOOD-DRIER

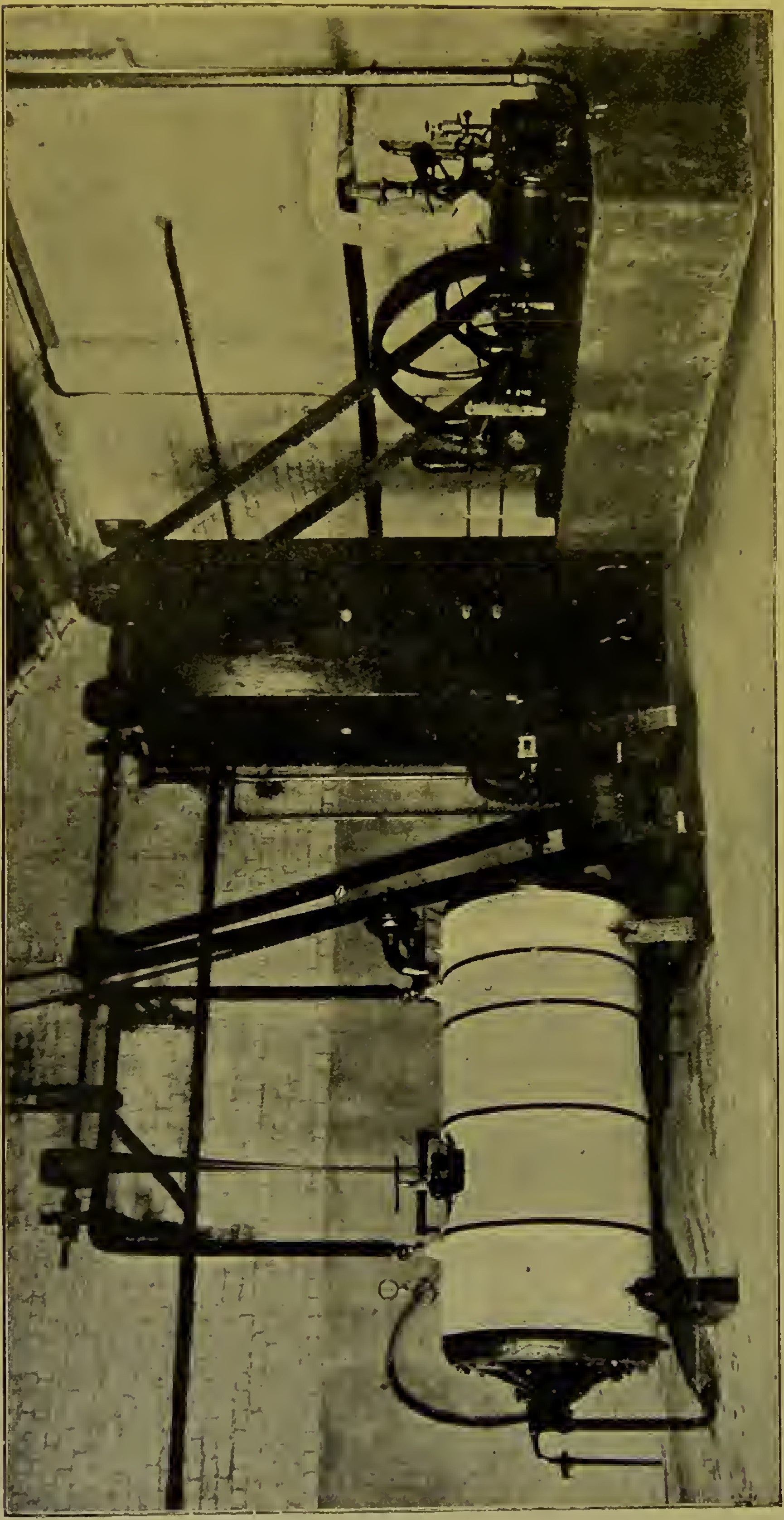


Fig. 16.—The Drying-room of a Blood Factory in Scotland

water-tower and then into the boiler fire. The average time taken to dry a batch of blood is about seven hours.

Another form of drier sometimes used is the vertical pattern (Fig. 15). It is a shallow pan, steam-jacketed on the bottom and partially on the side, with gear which scrapes the inner drying surfaces.

In Fig. 16 we have an illustration of the drying-room of a blood factory in a large town in Scotland, showing the water-tower alongside the horizontal drier.

Dried blood is an excellent but slow-acting fertiliser; it is usually blended with other ingredients into compound manures. As a preliminary, it is first ground fine in one of the mills which will be described under the next heading.

Bones. In bacon-curing works, wholesale sausage factories, and in

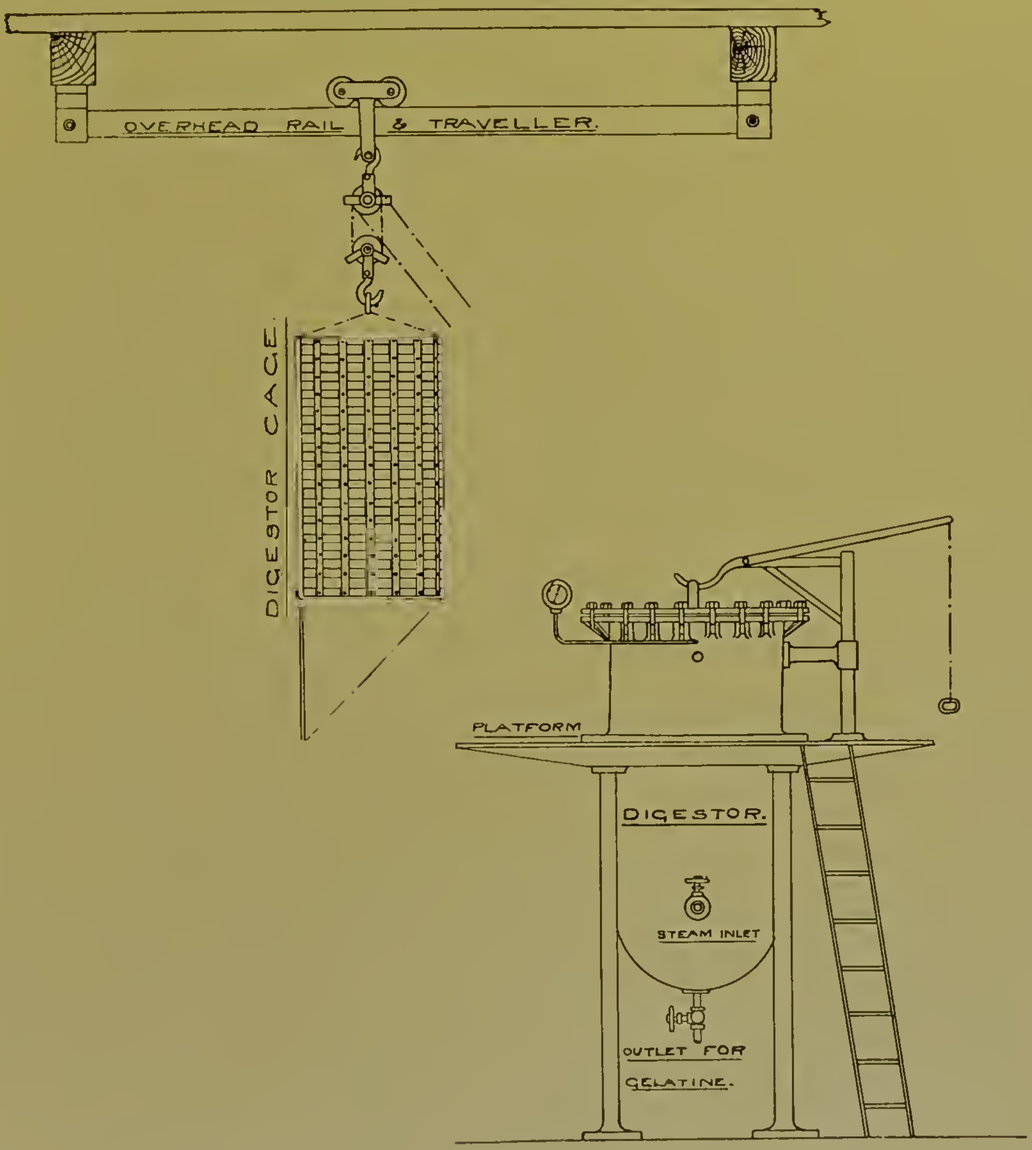


Fig. 17.—Design showing the General Arrangement of a Bone-digester

The apparatus is constructed so that a cage containing the bones may be lowered into the digester, and in this way it is possible to make the steam come quickly and directly in contact with the bones.

abattoirs recently built for some of the larger co-operative societies, bones are worked up in the fresh state, and the fat extracted used for blending with lard, making into dripping, &c. A very convenient plant for extracting fat by steam is shown in Fig. 17.

The digester, of 5-cwt. capacity, is mounted on iron columns, with deck-plate floor near the top for convenience of handling the lid and bone-cage. A small crane is shown on the right for lifting the lid, swinging it aside and holding it until required. The bone-cage has a hinged bottom, so that the contents can be discharged at once. The cage is lowered to the ground by the block and tackle, filled with bones, hoisted and run along by the overhead traveller until it is over the digester. The lid having been taken off and swung aside, the bone-cage is lowered into the digester, and the lid replaced and made steam-tight by the hinged bolts on the side. On the lid are a pressure-gauge and safety-valve; steam is turned on, and the gauge is kept at a pressure of 25 lb. or thereby. The cock at the bottom is kept slightly open all the time, and the fat and condensed water allowed to trickle out and fall into a wheeled truck placed underneath. In this way the fat is submitted to the minimum of steaming, and is of better quality in consequence. An hour is sufficient to steam out all the fat that can be economically extracted. Unfortunately, the process is not a very perfect one, as something like a half of the fat is left behind in the bones, but it is the only direct way of extracting the fat in an edible condition. If it is desired in addition, to extract gelatine, the steam pressure, after the fat is extracted, is raised to 40 lb., and kept at this figure for three or four hours. The run-off cock is kept dribbling as before, and a strong solution of gelatine runs off, which is useful in brawn-making and even forms the basis sometimes of confections known as "jujubes," "fruit pastilles," &c.

The bones left in the digester are in a soft and chalky condition and are easily ground into bone-meal, as described later. As a preliminary, they are dried on a kiln, preferably constructed of flat sheet-iron trays resting on steam coils. The bone-meal obtained in this manner is of excellent quality, and much of it may be sold as poultry food.

On the large scale, the bones from abattoirs, shops, and other town-collected bones from private houses, hotels, &c. &c., are all worked up together. Some may be fresh, but the greater part are quite unfit to be turned into food-products, and the practice is to extract the fat for soap-making, &c., and the gelatine, where this is done, as glue. As we have already seen, the steam process of fat-extraction is a very imperfect one, nearly one-half of the fat remaining in the bones, and it has now been almost entirely superseded by the benzine solvent process, in which extraction is made with light petroleum oils, aided by steam-heat. These oils, which dissolve fat very readily, should, for the proper working of the process, have a boiling-point of about 212° Fahr., and on being fractionated very little should distil over below 212° Fahr., and little or nothing be left at 270° Fahr. The plant is shown in Fig. 18.

A is the extractor, which may hold anything up to twenty tons of

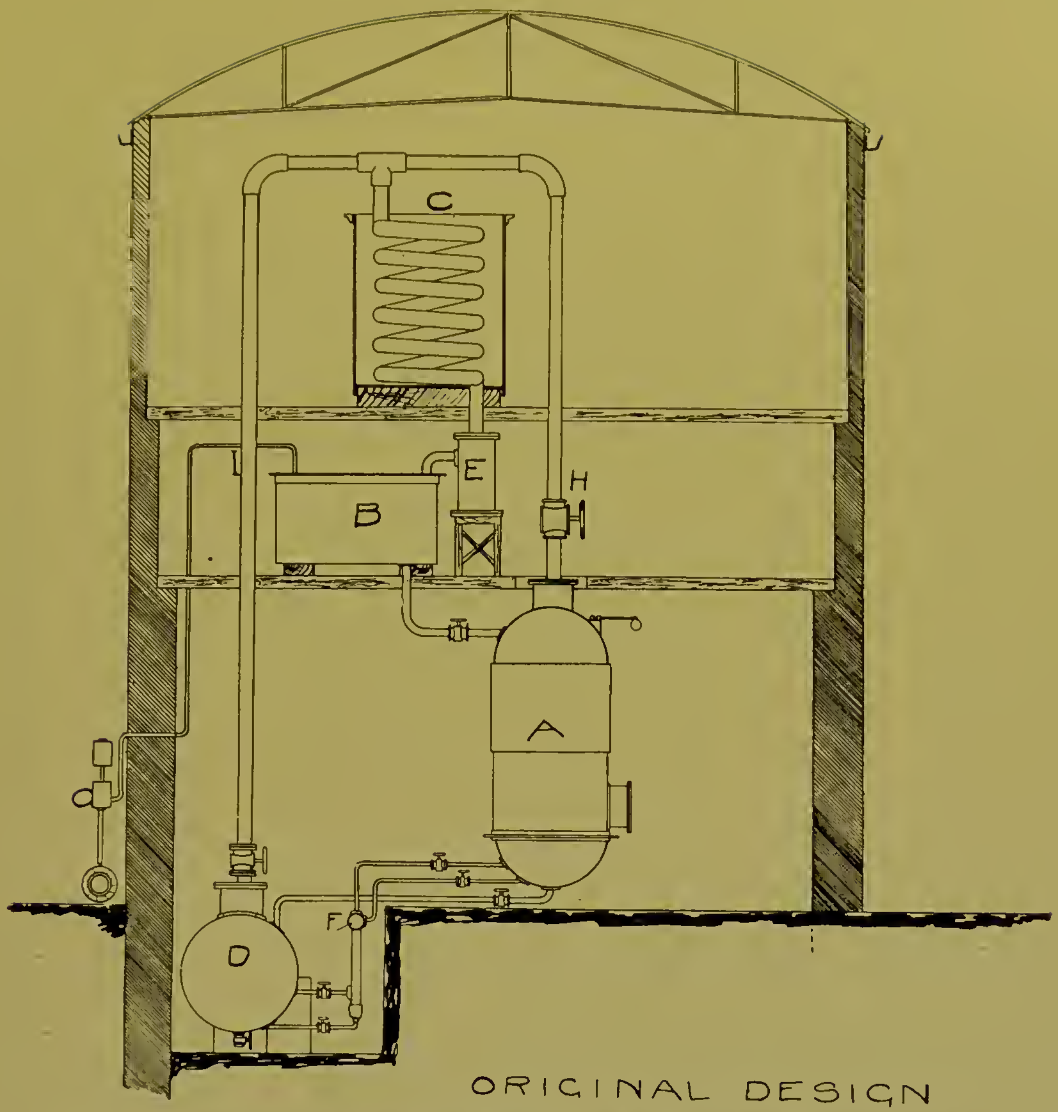


Fig. 18.—Apparatus for the Extraction of Fat from Bones by the Benzine Process

bones. They are charged through a man-hole in the top, preferably on a level with a floor, from which the bones can conveniently be shovelled in. The extracted bones are withdrawn through a man-hole in the side on a level with a perforated false bottom, to prevent the bones falling on to the steam-coils underneath. F is the steam main, from which branches are taken to the dry steam-coils, and the wet steam-supply to the extractor and also to the distiller D. The benzine stock-tank is shown at B. This tank is replenished by the pump G, which empties barrels placed underneath it and delivers the contents into the stock-tank. When the extractor is charged with bones, a foot or so of benzine is run into it from the stock-tank and the dry steam-coil turned on, which vaporises the benzine and sends it up among the bones, where it partially condenses and extracts the fat which descends in solution to the bottom, the uncondensed benzine vapour passing up the pipe H to the condenser C, from which it passes to the separator E, where water at once settles to the bottom and benzine floats at the top and is drawn off into the store-tank B. the water being run off by a pipe for the purpose. The rest of the benzine in the store-tank is run in gradually into the extractor, and the steam-supply increased. After a considerable proportion of the benzine has been redistilled back into the store-tank the cocks are closed, and the fat in the bottom of the extractor run into the distiller. Then the benzine in the store-tank is run again into the extractor, redistilled back, and the fat run a second time into the distiller. This operation is repeated a third and final time, and high-pressure wet steam is blown into the extractor to carry off the remaining benzine and moisture to the condenser. The bones can now be drawn out in a dry condition, ready either for glue-extraction or grinding direct into bone-meal. The fat left in them is usually under ½ per cent. Steam is turned on to the dry coil in the distiller and the benzine in the fat distilled through pipe I to the condenser, the distillation being completed by wet steam. Then the cock on pipe I is shut, and the fat forced by the steam pressure through another pipe (not shown) to the settling- and refining-tanks, where it is either barrelled after settling, or refined by treatment with permanganate of potash, or bichromate of potash and acid, and filtered.

For grinding the bones into meal for manure purposes, the disintegrator (Fig. 19) is much used.

It has a disc with radial arms called "beaters" driven at a high rate of speed. The upper part of the enclosing chamber has covers, with saw-shaped transverse corrugations, and the bones, driven round by the beaters, are broken fine against the corrugations. The lower part of the periphery has steel screens, through which the finely broken bone is passed by the action of the beaters, the grist depending on the width of the slits in the screens, so that meal alone, or a mixture of meal and rough-ground bones, can be produced at will. At one time there was a considerable demand for ¼ in. and ½ in. bone, but now little but meal is asked for, and the disintegrator is well suited for producing a uniform small grist. Another type of bone-crusher is that (Fig. 20) in which toothed rollers are used. This machine has the advantage of being able to crush green or damp bones, which would choke up the disintegrator.

The shank-bones of cattle are set aside and treated in a different way for the production of the raw material of bone-buttons, studs, tooth-brush handles and numerous other articles. The ends are sawn off and added to the general stock, but the intermediate part is cooked for several hours at a temperature not exceeding 190° Fahr., the fat extracted, skimmed off, and the bones washed and dried, when they are ready for the bone-turners.

We can only notice briefly the several methods of utilising disgreased bones, besides that of turning them into bone-meal.

The manufacture of bone-char by destructive distillation is a very important industry, the char produced being used on a large scale for refining sugar and on a smaller scale for other purposes, the fine char unsuitable for the sugar-works forming the basis of shoe-blacking and of some pigments. The process is similar to the distillation of coal in

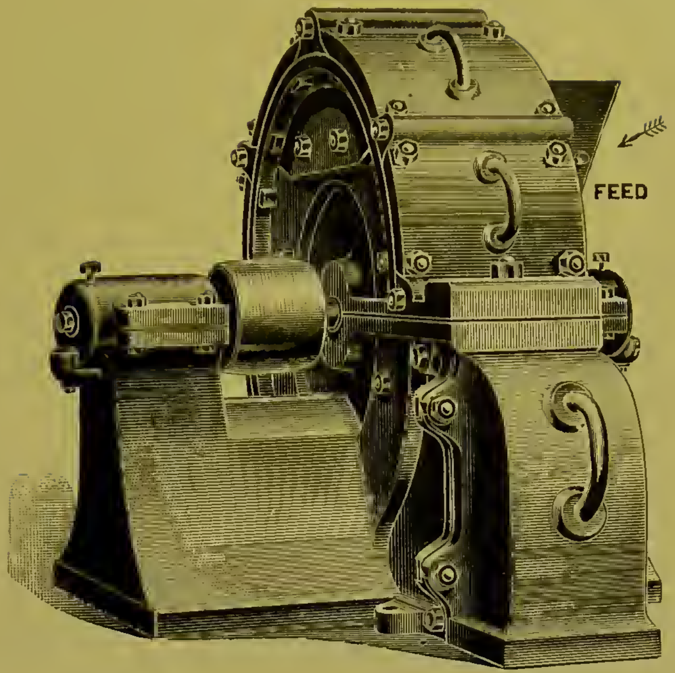


Fig. 19.—Bone-disintegrator for Grinding Digested Bones into Meal for Agricultural and other Purposes

The speed of this machine is 2500 r.p m. and the horse-power required is 20.

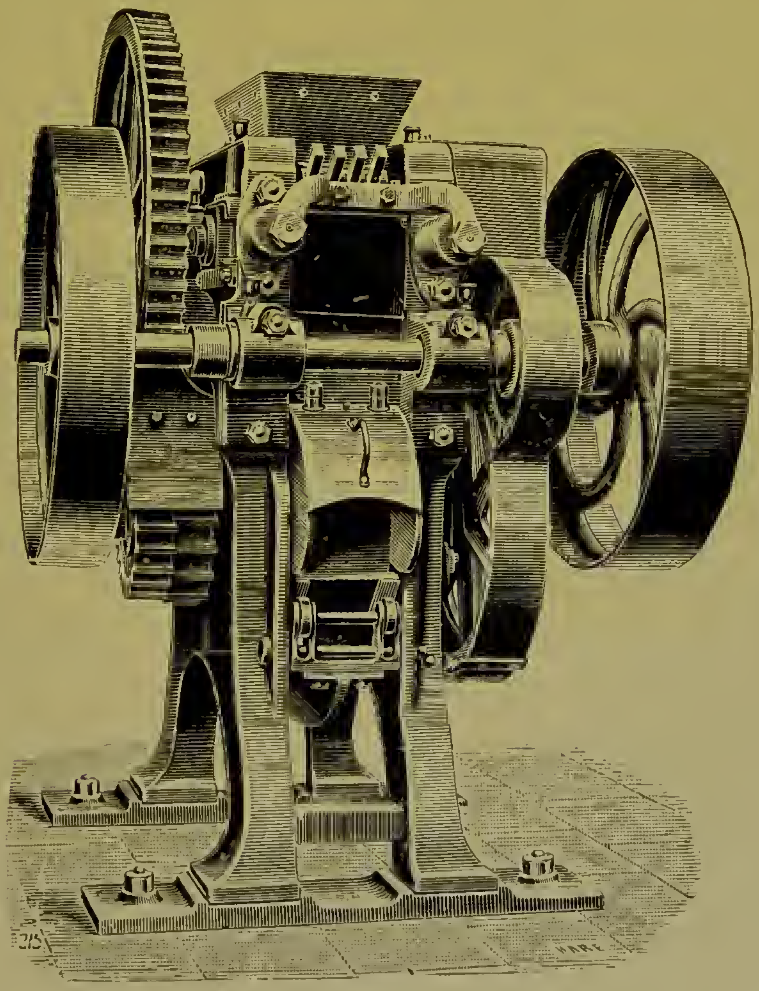


Fig. 20.—Bone-crusher

gas-works, the char being left in the retort, and the volatile products are tar, ammonia, water and gas. The latter is used to heat the boilers or retorts, the tar is redistilled to obtain a residue of about 10 per cent. of pitch, and the volatile portion is also used for heating the boilers. The ammonia-water is worked up into sulphate of ammonia.

The bones can be used for the extraction of glue in large steam digesters with water. The digesters are not unlike the extractors in the benzine process, but, in addition to the false floor, they have a central pipe through which the hot water circulates and flows over the bones, facilitating the solution of the glue. The pressure required is about 15 lb., and very concentrated solutions of glue are obtained in this way.

Another method is to submit the bones as they come from the fat-extractors to the ordinary method of glue-boiling in open pans about 8 ft. wide and 7 ft. deep, and with perforated false-bottom and central circulating pipe, as in the bone-digester above described. Underneath is a fire, and the bones, covered with water, are boiled until the gravity shows a content of about 10 per cent. of glue.

The manufacture of glue from skin-cuttings and other animal offal, received from the tan-yards and other sources, and to a limited extent from abattoirs, is conducted in the same way, with the exception that the skin-refuse, or "fleshings," is first prepared by soaking for a few days in lime-water, which has the effect of dissolving blood, &c., and turning the fat into an insoluble lime-soap. After thorough washing, the skin, &c., is placed in the glue-pan with water, and extracted in the same way as the disgreased bones. Gelatine is prepared in a similar manner, but greater care is taken in the selection and preparation of the materials. Bone-gelatine is also manufactured extensively. The bones must be quite fresh, and the soft, spongy parts are most suitable for the purpose. They are crushed small in a bone-mill (Fig. 20) and boiled in water to remove as much fat as possible. The next process is steeping in hydrochloric acid of 10 per cent. strength in wooden tanks well lined with pitch, and then thoroughly washing. The hydrochloric-acid solution of phosphate of lime is treated with excess of milk of lime, and the precipitated phosphate filtered, dried and sent to the manure works, where it fetches a good price. The cartilaginous matter left by the hydrochloric acid is extracted by boiling in water in glue-pans in the ordinary way. Sulphurous-acid solution may be substituted for hydrochloric acid ; it is not only a solvent of the lime phosphate but an excellent bleaching and preservative agent for the gelatine material. Indeed, sulphurous acid is used as a bleaching agent in all glue and gelatine processes. It is made by burning sulphur, and the gas may be used for treating the glue or gelatine materials or forced into the glue solutions, or it can be passed up wooden towers lined with coke, down which a stream of water trickles. In this way a solution testing about 6° Twaddell is obtained, which is used in place of hydrochloric acid, as already mentioned.

All these solutions of glue or gelatine are finished off in a similar manner. They are boiled down and cast into wooden moulds, and the jelly produced is cut into cakes of the proper thickness, which are dried in the open air on wooden frames with shelves of string-netting, with a small span roof on the top of each frame to throw off rain. After drying, the cakes are washed and brushed and dried again in a stove, when they are ready for the market.

Bone-ash which is imported in some quantity from South America for use in manure works, and in pottery- and glass-making, &c., is also sometimes made in this country by burning bones until white, on the hearth of a reverberatory furnace where the fire and the enclosed heating space are separate. The ash thus produced is the material from which the cupels for gold and silver extraction from the lead-alloy are made.

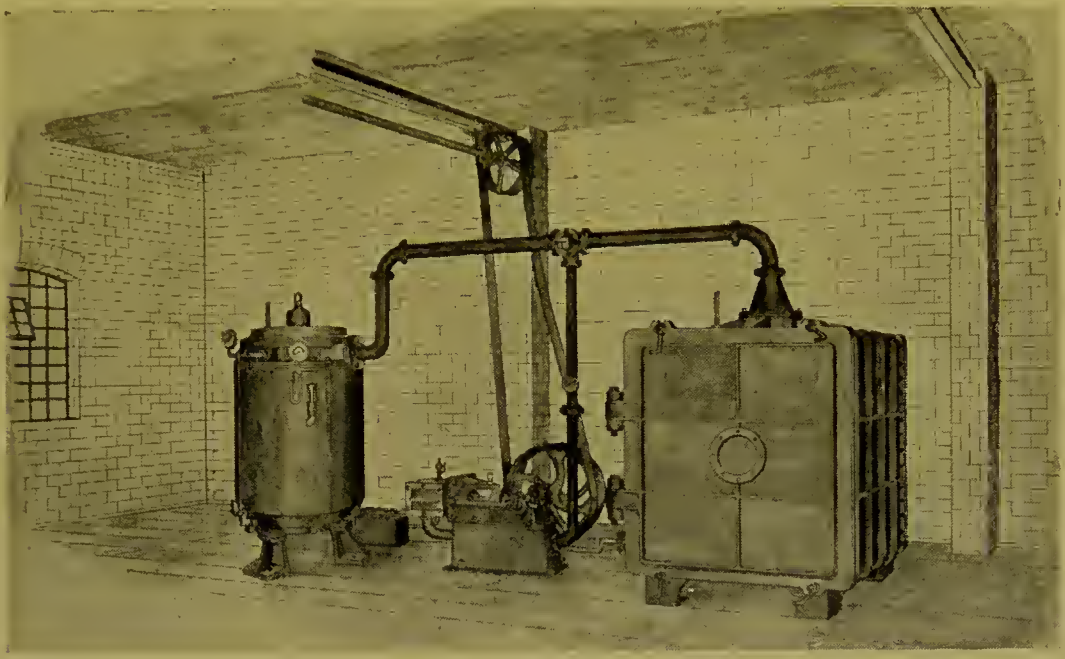


Fig. 21.—Gelatine and Glue Apparatus
In which the gelatinous extract is concentrated by means of a vacuum produced by an exhaust-pump. (Hawley.)

Entrails. The most important product from the entrails of cattle, sheep, and pigs, is sausage-casings, and as the method of treatment is similar in all cases, a general description will suffice. The gut-house should be kept scrupulously clean, and the walls preferably lined with glazed bricks ; any surfaces not faced in this manner ought to be very frequently lime-washed. The floor should be of concrete. A few wooden-vats or tubs and some tables are all the equipment necessary. The entrails must be at once cleaned when removed from the animal, otherwise they will get black, which deteriorates the quality. On the outside is a layer or web of fat, which is carefully removed with a blunt knife ; the skins are then deftly and rapidly turned outside in with the aid of water, and the inner surface washed and scraped clean with the blunt knife. Machines are now frequently used for this purpose. The skins are made up into proper lengths, and the greater part salted and placed in barrels. Some, however, such as weasands and bungs, are tied at the ends and blown up with bellows or with a hand- or power-pump. They are then dried in the air, and either sold in wind or pricked and put up in flat bundles. The principal casings are as follows:

Cattle-casings. *Weasands*, the lining of the throat, averaging from 18 to 24 in. in length. A quantity of "weasand meat" is trimmed from the outside of these.

Bungs, the large intestine, about 4 ft. in length. From the outside goldbeaters'-skin is obtained.

Runners, the smaller intestines, measuring from 90 to 130 ft.

Middles, larger intestines, from 18 to 35 ft. Both of these are usually salted.

Bladders. Generally blown up and pricked. Used for packing a variety of goods in, and for fishermen's floats, &c.

Sheep. The long, narrow intestines of sheep yield casings used for beef sausages, and sheep-bungs are also the covering for certain special sausages. The "haggis" is put up in sheep's stomachs.

Hogs. The narrow intestines of pigs are used on an enormous scale for pork sausages. The terminal part or "fat end" is sought after in Germany for a particular kind of sausage, the fat being left on. Hog-bladders, mostly salted and bleached, still find a large market as packages for lard.

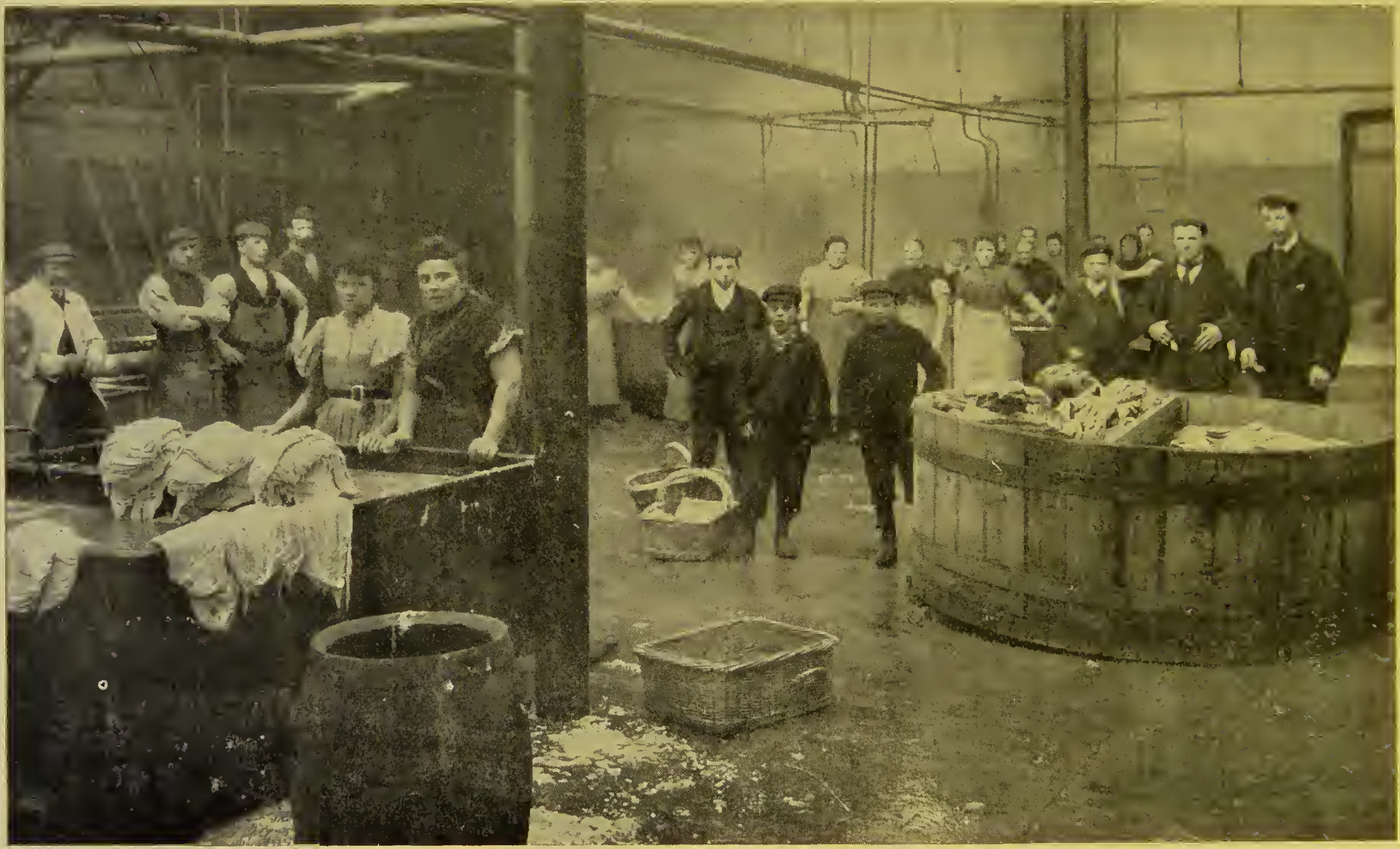
Waste pieces of all the above intestines are spun into strings and cords used for violins, holding clock-weights, for tennis-rackets, &c.

Tripe. The stomachs of cattle are made into tripe, and the methods of cleaning are various, but they all agree on the point that the process must commence without delay, as, if the stomachs are allowed to lie in a dirty condition, they become stained and the quality suffers.

The stomachs are first scalded in water, which should be at a temperature of about 130° Fahr. In some places a small proportion of washing-soda is added. Agitation is kept up until most of the dirt is separated and the tripes are taken out, scraped and brushed in a current of cold water. Circular machine-brushes, belt-driven, replace the hand-brushes in some abattoirs, and lime is occasionally used in the first washing-water. The tripes are then cooked in coppers until tender. Alum in the proportion of ¼ lb. to every ten gallons of boiling water, is frequently added as a bleaching agent. Wash again in a stream of cold water after cooking. To preserve the tripes, they may be steeped for a short time in water to which 10 per cent. of liquid bisulphite of lime has been added.

Chitterlings. On the small scale, pigs' entrails after cleaning are cooked and sold in pork butchers' shops as "chitterlings."

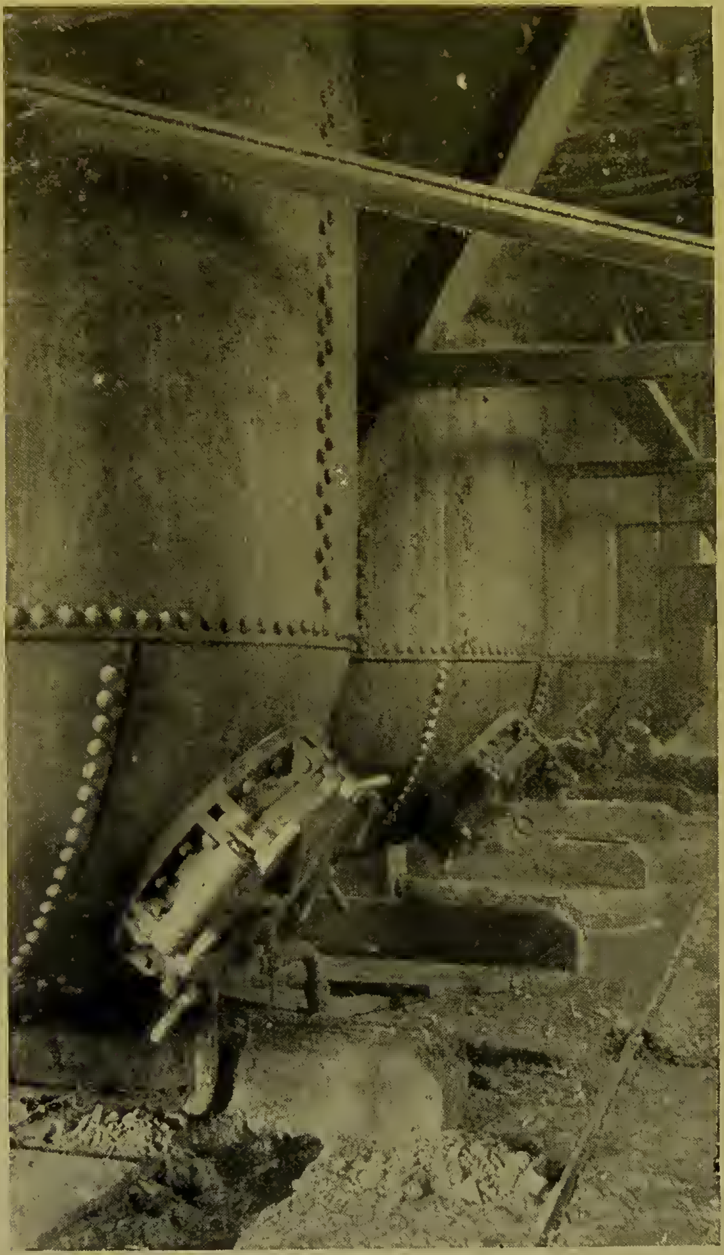
Pepsin and Pancreatin. The digestive enzymes, pepsin, and pancreatin are much used in medicine, and are prepared for this purpose especially by Armour and Co., of Chicago, who also extract the principles of the thyroid and suprarenal glands, which have proved to be valuable remedies. Pepsin, the active agent of the first or acid digestion, is extracted from the stomachs of pigs, sheep, and calves. These are carefully cleaned, and the pepsin can then be squeezed out as a thick fluid. It is tested as to



The Tripery in Glasgow Public Abattoir

its digestive capacity and then dried up at a temperature of about 100° Fahr., with certain neutral diluting materials to standard strengths. Pancreatin, the secretion of the pancreas, which produces the second or alkaline digestion, is prepared in a somewhat similar manner.

Rennet. From the fourth or true stomach of the calf, rennet is prepared. The stomachs have their outer skin taken off and fat carefully removed, and they are then salted and dried. It was the practice at one time to put a piece of the dried rennet in milk, to be curdled for cheese-making, &c., but now, concentrated essences of standard strengths or tabloids similarly graded, are prepared in technical laboratories, and are in universal use.

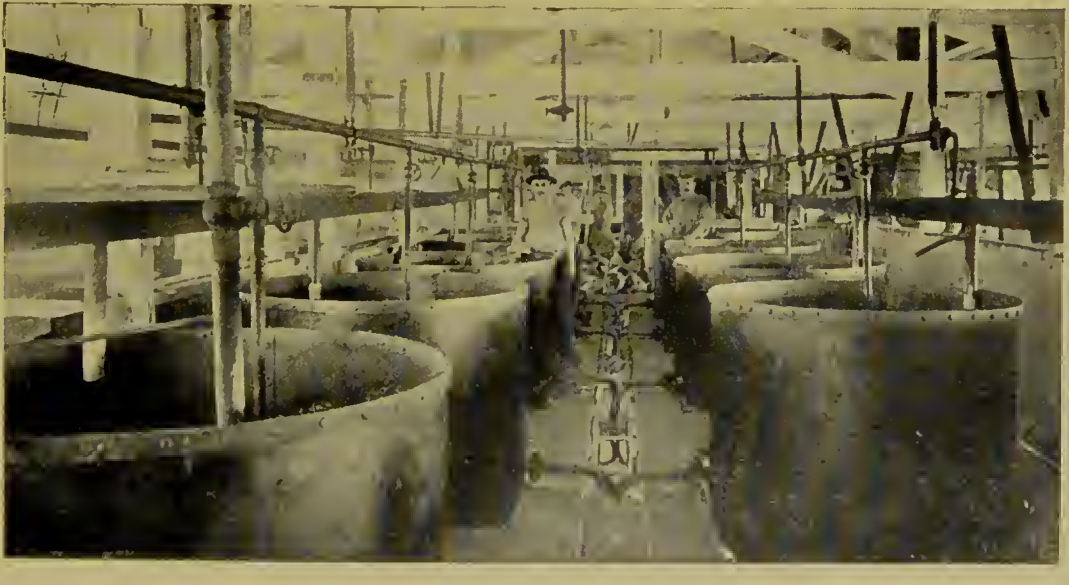


View of Tallow-digesters

Hoofs and Horns. Although celluloid is used in large quantities as a substitute for cattle-horns, the demand for the latter has not fallen off, and the price has gone up to a very high figure. Horns are still much used for making combs, &c., and cattle-hoofs for making buttons. The preparatory process in each case is steeping in hot water, and in the case of horns, beating of the softened material with a mallet loosens them from the core, and when the latter is removed the horns are dried and are ready for the manufacturers. The soaked hoofs are split off. The trimmings and cuttings from the bones and hoofs, and damaged pieces and hoofs that cannot be used for button-making, can be manufactured into yellow prussiate of potash (potassium ferro-cyanide), which in turn is made into the pigment Prussian blue and used in various other ways. Any other animal offals such as blood, hair, bristles, &c., can be worked up in the same way. The process

Fertiliser Department in the Meat Export Works, Queensland

The Oil Department in the Meat Export Works, Queensland



The Tallow-refinery in the Meat Export Works, Queensland consists in heating together the animal matters with carbonate of potash and iron in cast-iron retorts, the melted mass is lixiviated in water at the boiling temperature, and the liquor resulting, after settling clear, is allowed to cool and crystallise, and the crystals of yellow prussiate can be further purified by re-solution and recrystallisation.

Hair and Bristles. The hair of cattle is not usually a direct product of the abattoirs. It goes with the hides to the tanners, who separate it from the skin by steeping in lime, or by the use of other chemicals. The crude article from the tan-yards is extensively used by plasterers as a binding material, but for other purposes it is necessary that the hair should be purified. The process most in use is treatment with hydrochloric acid, which removes the lime and other impurities and thoroughly sterilises the hair. It is then dried, first in a centrifugal machine and then in hot-air rooms. Dried hair is a capital insulating material; it is very light, and its non-conducting capacity is very high. Made into webbing backed with canvas, it is used extensively for insulating steam-pipes and brine-pipes, refrigerating evaporating tanks, and many other purposes where temperatures are not high enough to destroy the fibre.

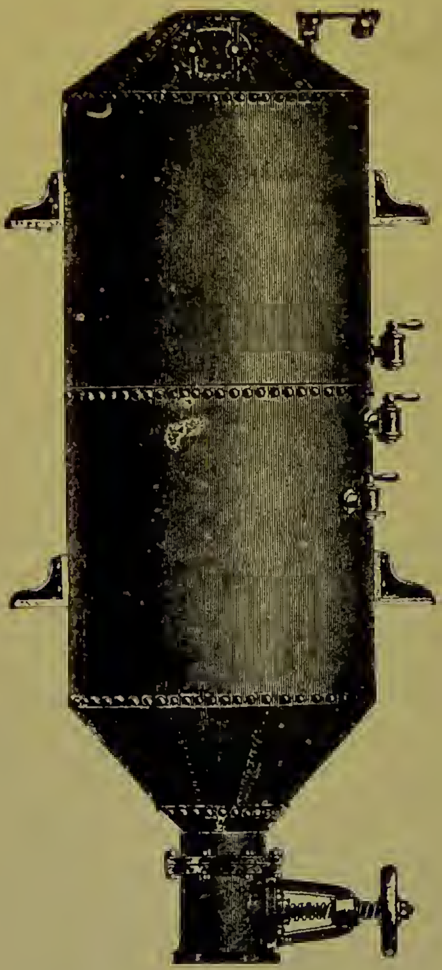
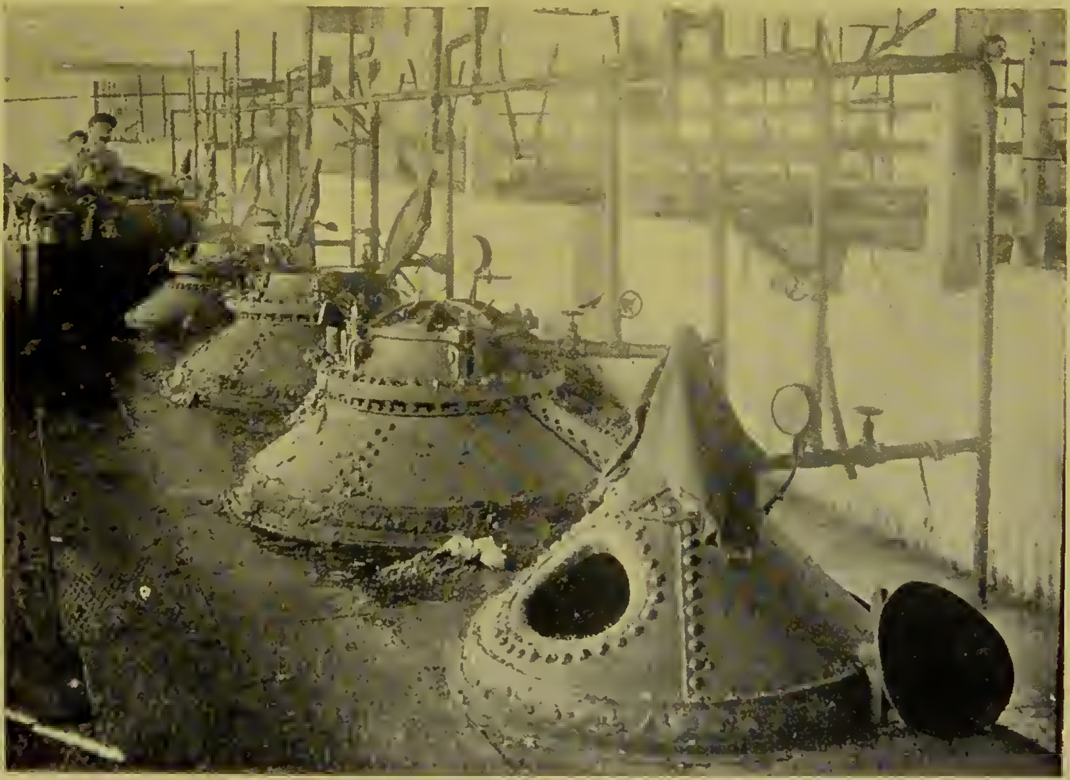


FIG. 22.—AMERICAN DIGESTER

The trade of brush-making in the different branches, which deal with painters' brushes, hair-, tooth- and shaving-brushes, domestic brushes, &c. &c., requires enormous quantities of bristles, but only a very small proportion of what is needed is produced in this country. Our improved breeds of pigs yield a very poor quality of bristle, and the same remark applies to the pigs of America and several European countries. The nearer the pigs approximate to the wild breeds the finer the bristles, and it is to Russia that our brush-makers look for their finest material. Still, a certain proportion of merchantable bristles, of an inferior quality, is obtained from British pigs, and in the bacon factories and abattoirs the men who scrape the pigs after scalding select the strongest of the bristles which grow along the back and lay them aside. Bristles are prepared for the market by steeping in sulphurous-acid solution, a weak solution of vitriol, or long bleaching in the sun with frequent turning. They may also be purified and freed from scurf by boiling and washing. The short hair of pigs can also be purified by the latter method, and is used by bedding manufacturers for stuffing mattresses, or by furniture-makers and upholsterers as padding for chairs, cushions, &c. Sometimes lots

Extract Plant in the Meat Export Works, Queensland



The Digesters and Tallow-refinery in the Meat Export Works, Queensland of waste hair find their way to the manure-works, and are dissolved along with mineral phosphates, by sulphuric acid, into "ammoniated superphosphate," and, with the addition of ground bones, into "compound dissolved bones" and other manures.

In the American packing-houses large quantities of waste bones, blood, hair, entrails, and other offal is collected and classed as "tankage," and worked up into fertilisers of various grades. The tank-house in the larger establishments is now a separate and specially designed building of three stories. To the upper floor, a battery of tanks (Fig. 22) or digesters of large size is hung. Under each tank is a receiving vat, which takes the contents of the tank after thorough steaming. The steamed material is pressed in hydraulic presses, and the vats are placed at such a height that the contents can be most readily transferred to the presses.

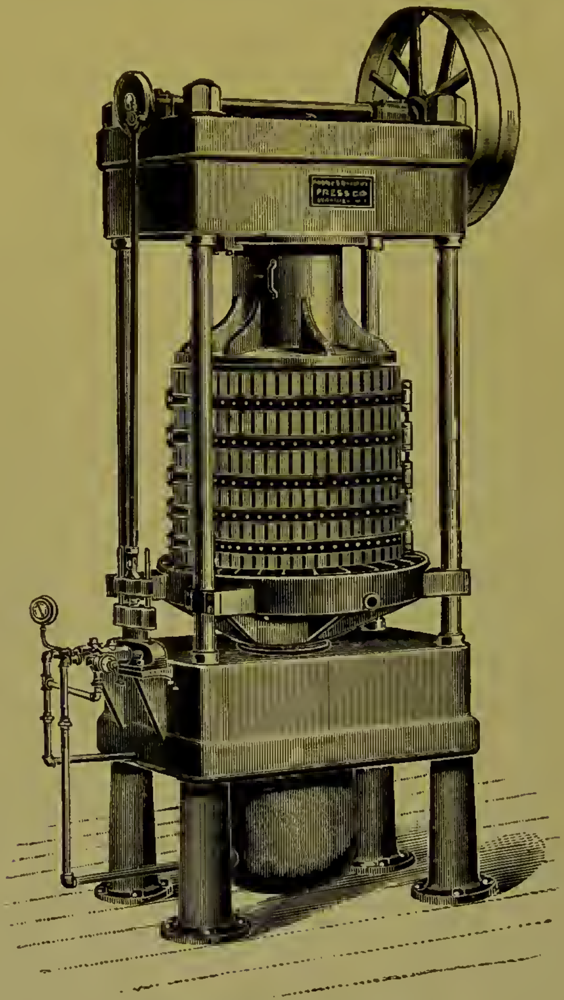


FIG. 23.—BOX-PRESS

The pressed material is dried in horizontal rotary or circular driers, like those used for blood. The process is as follows:

The offal is fed into the tanks from the upper floor, and cooked in water for a short time. The water is then drawn off and reserved for use with the next batch. Steam at 40-lb. pressure is then turned on,

By-products: A Corner of the Meat Export Works, Queensland

and steaming continued for ten or twelve hours. As much fat as possible is drawn off through cocks placed at different heights on the side of the tank. When the steam is turned off, the contents of the tank are allowed to fall into the vat underneath by large full-way valves. If there is not enough water to float off the fat, some of the press water from previous operations is added.

When the fat has been removed, the water is drained off and the residue pressed either in box-presses (Fig. 23) or in plate-presses.

The water from the press is allowed to settle and the fat skimmed off. All these waters are highly putrescible, and are maintained at a temperature of not lower than 100° Fahr. so as to avoid decomposition. The surplus liquid, which is very rich in ammonia and alkalies, is evaporated in vacuum pans or added to the cake in the rotary driers. In either case it requires treatment with vitriol and sulphate of iron (made by dissolving scrap-iron in vitriol) to overcome its troublesome tendency to deliquescence. Finally the dried fertiliser is ground in suitable mills and graded according to analysis. The larger packers compound their fertiliser with sulphate of ammonia, superphosphate, potash salts, nitrate of soda, &c., into various special manures for different crops, and sell them direct to the farmers.

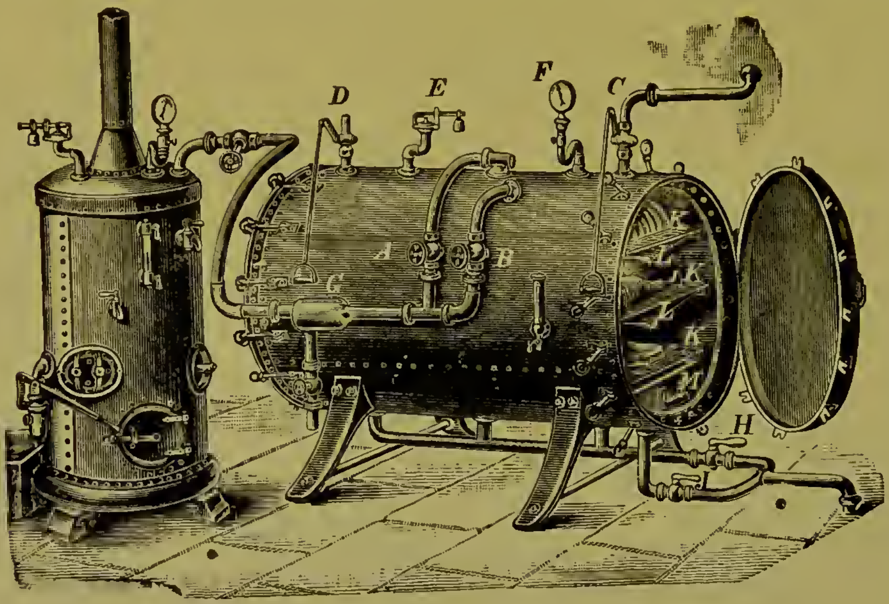


Fig. 24.—Dr. Rohrbeck's Meat-steriliser

Diseased Carcases. The disposal of diseased and condemned meat has not received the attention it deserves in the United Kingdom, and appliances of a scientific character for its proper treatment are conspicuously lacking. In Germany and Denmark a distinction is made between meat which is only slightly diseased, and which may, after treatment, be used as food, and more seriously affected meat which cannot be so used. The slightly diseased meat—mostly tuberculous—is cooked under official supervision in the abattoir, and retailed at cheap prices to poor people under what is called the "Freibank" system. For the treatment of this meat, various special forms of apparatus have been devised and put into use, after careful testing by experts.

Rohrbeck's Steriliser. The best known is Dr. Rohrbeck's Steriliser (Fig. 24), consisting of a steam-jacketed cylinder, with hinged doors at either end, with hinged wing-nuts for fastening them steam-tight. Inside are shelves for holding the meat to be sterilised and cooked. The steam-producer is on the left, and the apparatus is fitted with safety-valve, pressure-gauge, and a pipe for spraying in water, as it was found that partial condensation of the steam assisted the cooking. The meat is cut into convenient pieces and packed on the shelves. Into the larger parts tell-tale thermometers are thrust, with electrical connections which cause a bell to ring when the temperature in the centre of the meat has reached the sterilising point—212° Fahr. Exhaustive tests have proved the efficiency of this apparatus. Tuberculous meat treated in it and inoculated into guinea-pigs produced no symptoms of disease.

This apparatus is described by the patentee as follows:

"This disinfector consists of a double-walled iron cylinder 2.62 metres long and 1.68 metres in diameter. It has two doors of iron. which can be hermetically closed by means of screws. In the interior of the apparatus are movable iron crates or trays, arranged in tiers one above the other, upon which the pieces of meat, &c., are put. Under each crate is a zinc dripping-pan, which receives the gravy and fat from the meat and conveys them into a large zinc vessel placed at the bottom of the apparatus for that purpose.

"The apparatus is connected with the steam-supply of the abattoir, in whose boilers there is generally a steam pressure of from 2 to 2.5 atmospheres pressure. The disinfector is built for a pressure of one atmosphere, but, as a rule, experiments made have been conducted with a steam-pressure of half an atmosphere; occasionally, but only for a short time, with three-quarters of an atmosphere.

"The steam enters from above, and can be conducted, as may be desired, either direct from the boiler or first through the double walls or jacket of the apparatus into the air. When the steaming process is at an end, the apparatus can be made to work as a drying space by means of a special valve, which causes the steam to circulate between the double walls (this is only necessary when the apparatus is used for other disinfecting purposes). The steam escapes from the bottom of the boiler through several outlets, which lead into the waste-pipe.

"One peculiarity of this apparatus is a cooling arrangement which, by means of cold water, produces condensation of the steam and a negative pressure in the boiler, which pressure is indicated by the pressure-gauge. The object of this condensation is to obtain absolutely saturated steam. Besides this, however, it has been proved, by experiments, that repeatedly condensing the steam causes differences of pressure which are most favourable to quick and efficacious cooking.

"The apparatus is very easy to manage.

"In the course of some experiments made, it was found that small objects did not afford sufficient scope to give a reliable proof of the capacity of the apparatus; the side of a bullock, some hundredweights of liver, lights, &c., were therefore reserved for each experiment.

"The meat, before being laid upon the shelves, was cut by a butcher into pieces of about 12 to 15 cm. thickness and 3 to 6 kilos weight. Such cubes of meat as are mentioned in the experiments Nos. 5 to 8 could only be obtained by being cut from the legs of full-grown bullocks. An incision was sometimes made in the liver and lights, but only when these were considerably enlarged by pathological causes.

"As soon as the meat was put upon the shelves, a tested maximum thermometer was stuck into the middle of some specially selected pieces, while those pieces which were obviously difficult to steam, were furnished with a contact thermometer, which latter—as soon as a temperature of 100° Cent. was reached—signalled the fact by setting in motion a bell placed on the outside of the apparatus. The conducting-wires fastened to the thermometers were connected with cable-wires, which, being passed through the walls of the apparatus, communicated with an electric battery and the numbered signal-bells. In this manner it could immediately be ascertained when the temperature in the centre of certain pieces of meat had reached 100° Cent. In order to control the highest temperature in the boiler itself, a tested maximum thermometer was also hung up there.

"These experiments regarding the penetration of heat into the meat yielded very interesting results.

"As is shown in the following Table, beef of different quality, and taken from different parts of the animal, was made use of, and it was found that quite lean beef is the hardest to be thoroughly cooked. Of course such pieces of meat as were used in experiments Nos. 5 and 8 will scarcely ever be met with in the market, but even in these there was a temperature of 100° Cent. in the interior, after about two and a half hours' steaming. On the other hand, joints of meat such as are usually seen in the market require to be steamed for a much shorter time."

Hartmann's Apparatus. Another apparatus for cooking and sterilising meat was invented by Hartmann (Fig. 25). It has no jacket, and the steam is blown into a small reservoir of water in the bottom giving, it is claimed, a steadier temperature and purifying the steam from any contamination it may carry with it. The latter claim is rather an illusory one. The meat is held in movable flat vessels made of perforated iron.

In both Rohrbeck's and Hartmann's apparatuses, the pressure maintained is 7 to 8 lb. per square inch.

The proper treatment of condemned meat unfit for food involves the following considerations:

(1) It should be handled as little as possible, and to secure this, the apparatus for treating it should be in a special department in the abattoir itself, and with an overhead trackway communicating with the general

RECORD OF EXPERIMENTS WITH ROHRBECK'S STERILISER

Experiment No.	Duration of Experiment.		Joints of Meat.	Quality.	Size.	Weight.	Signal (100° C.) after.		Maximum Thermometer hung up in Apparatus.	Maximum Thermometer in Centre of Meat.	Loss in Weight.	Soup gained.
	Hr.	Min.			Cm.	Kilo.	Hr.	Min.	°C.	°C.	Kilo.	Kilo.
1	2	15	Joint for roasting	Lean	15	3.00	—		117	104	1.125	—
1	2	15	Sirloin	Fat	15	2.750	—		117	102½	1.125	—
1	2	15	,,	Streaky	12	3.250	—		117	110	1.250	—
1	2	15	Shoulder	,,	12	3 250	—		117	106	1.250	—
2	2	15	,,	,,	15	4.750	—		117½	109½	1.500	—
2	2	15	Ribs of beef	Fat	Not noted	3.250	—		117½	107	1.250	—
2	2	15	Shoulder	Streaky	12	5.00	—		117½	113½	1.500	—
2	2	15	,,	,,	12	5.00	2	9	—	—	1.500	—
3	2	26	Joint for roasting	Lean	15	5.500	2	10	118	110	2.250	—
3	2	26	,, ,,	,,	15	3.250	2	13	118	110	1.250	—
4	2	12	,, ,,	Streaky	15	2.750	—		118	104	1.375	—
4	2	12	Rump of beef	,,	12	2.500	1	52	118	—	1.250	—
4	2	12	Joint for roasting	,,	15	3.750	2	—	118	—	1.500	—
4	2	12	,, ,,	,,	12	2.625	1	33	118	—	1.250	—
4	2	12	,, ,,	,,	15	4.125	—		118	108	2.00	—
5	2	—	Meat without bone		10 × 11 × 15	1.625	2	—	Not noted	100	0.750	—
6	2	30	,, ,,		11 × 13 × 20	3.00	2	25	115	101	1.375	—
7	2	45	,, ,,		15 × 15 × 15	3.250	2	35	118	103	1.250	1.250
8	3	—	,, ,,		12 × 12 × 15	2.750	2	35	118	105	1.250	1.300
8	3	—	,, ,,		10 × 15 × 15	2.500	2	35	118	104½	1.00	—

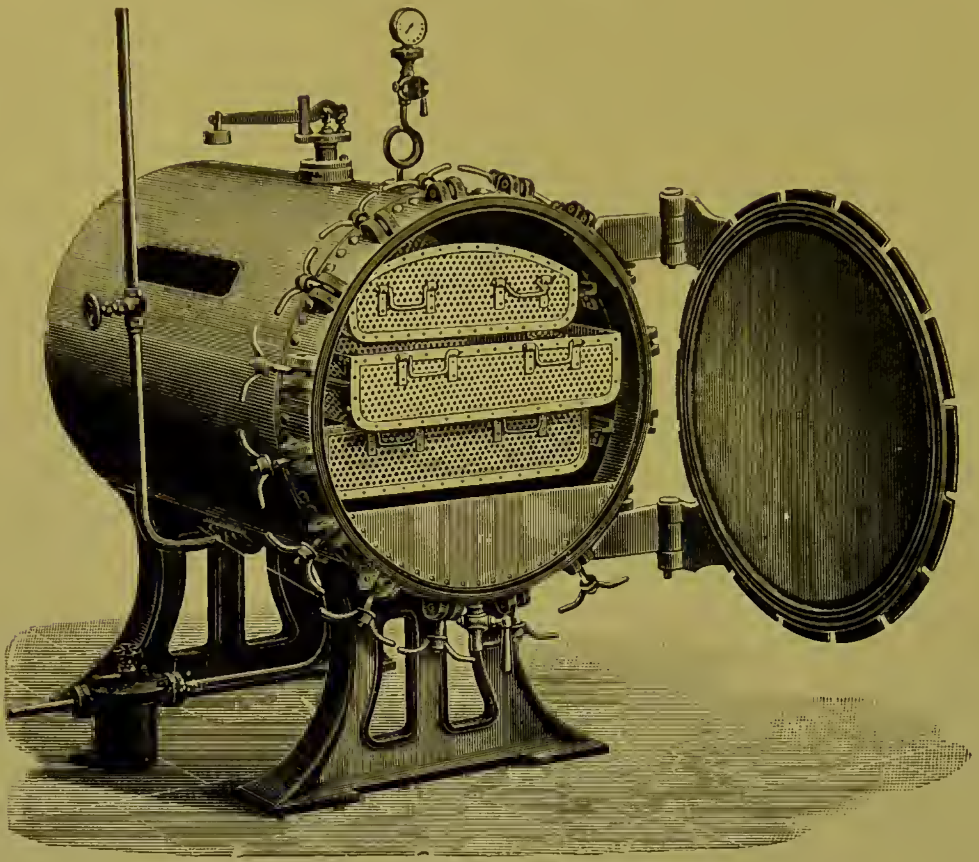


FIG. 25.—HARTMANN'S MEAT-STERILISER

trackway of the abattoir, so that the carcases can be brought into the department suspended from a wheel-hook and they should touch nothing but the wheel-hook all the journey.

(2) The process should not be of such a character as to be offensive to the neighbourhood.

(3) The products should, if possible, be of a useful character.

The Podewils Apparatus. The apparatus which seems to most fully carry out these requirements is that of the Podewils Company, which is in general use in German abattoirs and has been installed in the Metropolitan Cattle Markets, Islington, London.

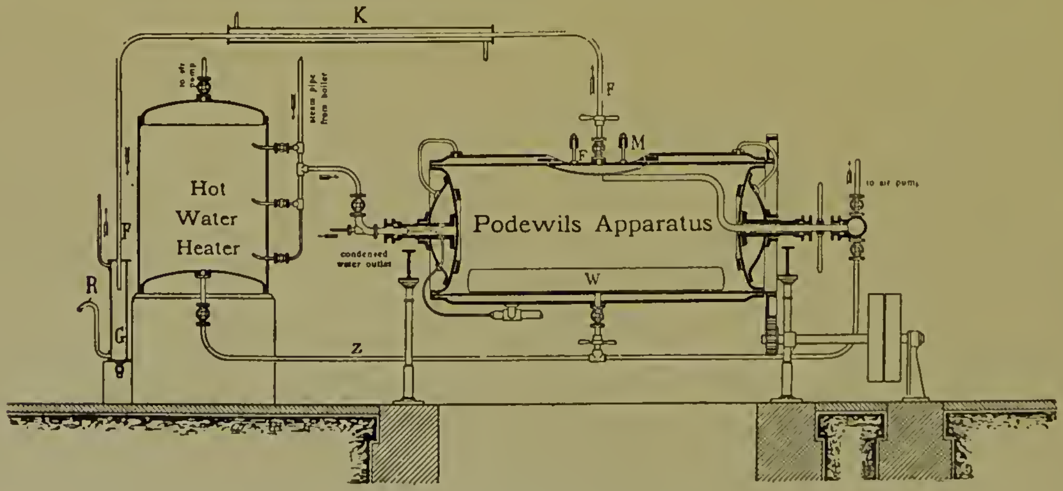


FIG. 26.—PODEWILS APPARATUS

The apparatus is made in various sizes, as set forth in the following Table, which also gives the capacities and component parts of each complete plant.

Number of the Apparatus .	No. 1	No. II	No III	Tilting drum *	No. IV	No. V
Charges and guaranteed minimum output in ten to twelve hours . carcase	cwt. 7	cwt. 10	cwt. 18	cwt. 18	cw t. 27	cwt. 36
Approximate amount with continual working during twenty-four hours . carcase	cwt. 12½	cwt. 18	cwt. 32	cwt. 32	cwt. 45	cwt. 62
Necessary boiler-heating surface — in superficial square feet . . .	65	97	162	162	216	269
Horse-power required .	1	1	1–2	1–2	2	2
Building room required including side passages—in super. square feet . .	108	130	162	216	216	269
Inside dimensions of the drum :						
Inside diameter in in.	39½	39½	39½	48	59	59
Length . in in.	39½	60	98½	79	98½	138

The following are included in the outfit as supplied by the patentees : One hot-water heating-vessel, one condenser, one fat-cooler, one gas-separator, one filling-chute, one propeller, boiler, connecting-pipes, &c., about 30 ft. in length, connecting-pipes for the single machines. The following are not included : Steam boiler, steam-engine or other motive-power, air-pump, shafting, delivery and return pipes, foundations, fitting up or any structural works.

Fig. 26 is a diagrammatic representation of the principal portions of the plant.

The carcases are placed in a revolving cylinder, jacketed all round, and with conical steam spaces at either end. On the one hand is a hot-water heater, and on the other a connection to an air-pump. On the bottom is a connection, Z, from the heater to the cylinder, and on the top a man-hole for charging and a pipe, F, by which fat is floated off to the separator, G, passing through a Liebig's condenser, K, on the way.

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* The tilting-drum and the apparatus No. V work up *whole* carcases of diseased animals of *large* size.

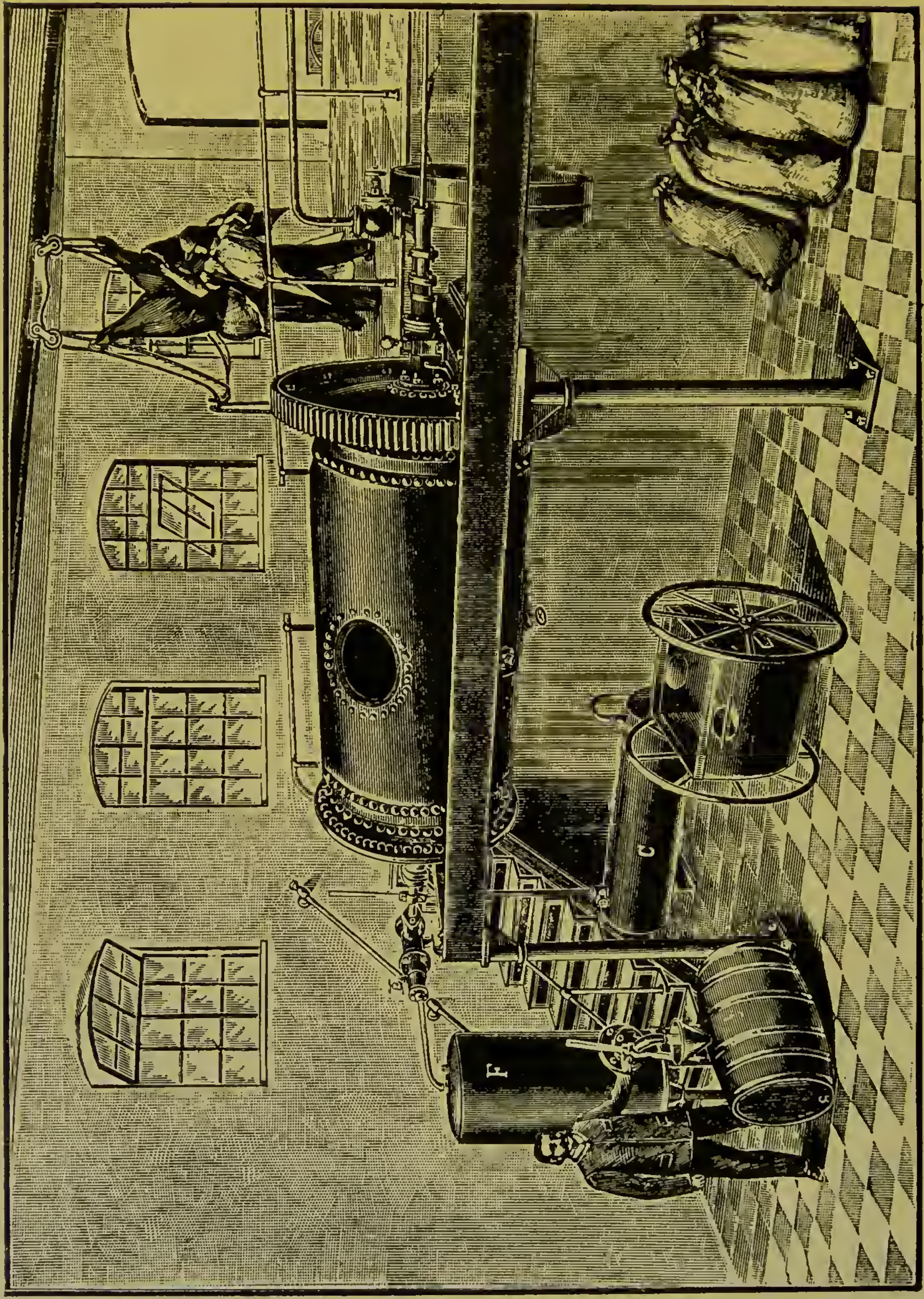


FIG. 27.—GENERAL VIEW OF PODEWILS PLANT

In the bottom of the cylinder is a heavy roller, W, which crushes the steamed material, liberating fat and grinding the meal to a powder. The cut-up carcase is charged in through the man-hole, which is then fastened steam-tight. The air-pump is started and air exhausted from the cylinder. In the meantime, steam has been run into the water in the heater, boiling it and bringing the pressure up to about 45 lb. per square inch. The cock on pipe Z is opened, and water passes from the heater to the cylinder. Pipes F and Z are then disconnected by rapid-acting Dutch screws. Steam is turned on to the jacket and end steam spaces, and the pressure in the cylinder is forced up to 45 lb. and kept at this for four hours, the cylinder being occasionally rotated. Pipes Z and F are again connected, and the remaining hot water from the heater is run in, and the fat is floated to the top and passes up pipe F, through condenser K, to G, where the gases are separated and the fat which is clean and cool is run into barrels. Z and F are again disconnected, the apparatus is rotated and the air-pump started, and drying is completed in about six hours. The man-hole is opened and rotation resumed for about ten minutes, when the dried material will all fall out into trucks underneath. The air-pump delivers the steam and gases to a condenser, and the condensed water is run to the drains, while the gases, with those from the separator G, are burnt in the boiler fire. The meat-meal obtained is sold for feeding poultry or fish, or as manure, and the fat goes to the soap and candle works. A steam boiler and engine form part of the plant.

Fig. 27 gives a general view of the plant, minus the air-pump, engine and boiler.

In cases where it is desirable to work up whole carcases a special form

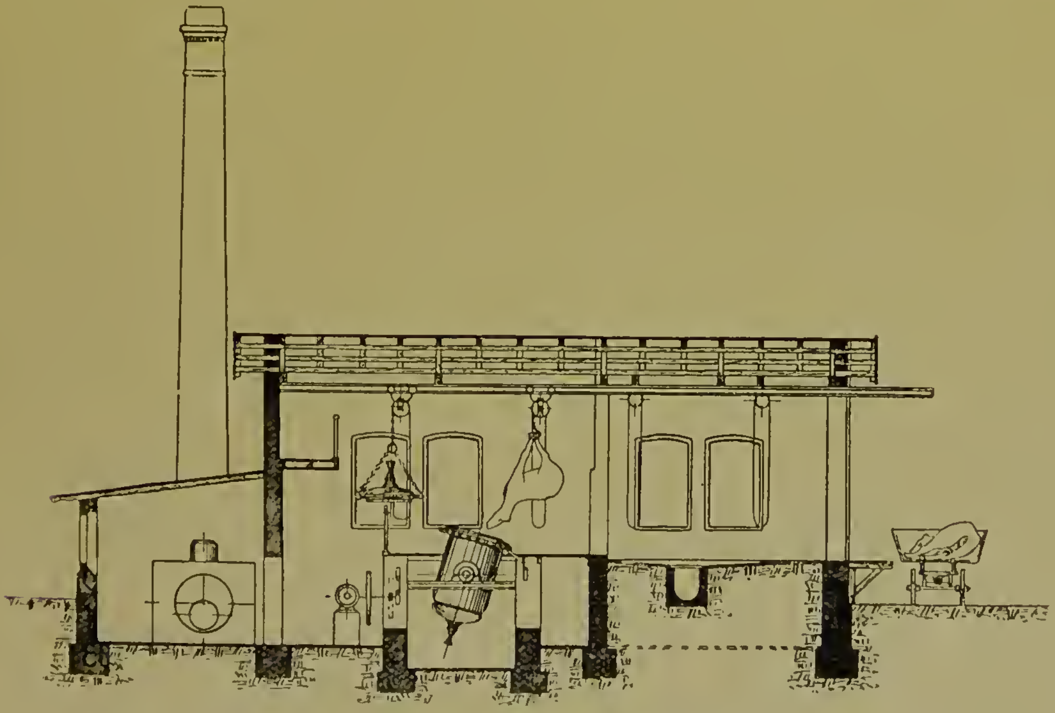


FIG. 28.—PODEWILS TILTING-CYLINDER

Date.	3/4/08.	10/4/08.	
Time plant was working . . min.	440	390	
Steam consumed in the cylinders lb.	2,332	2,398	
Steam consumed in the cylinders per hour . . . . . . lb.	321	370	
Average horse-power required.	6	7	
Total steam . . . . . lb.	7,110	5,874	
Steam required for pumps . . lb.	990	1,056	
Steam required for drying, cooking, and working the cylinders . lb.	6,120	4,818	
	No. 2 Cylinder.	Two cylinders.	
Raw material put into cylinder:			
Meat, bones, entrails . . lb.	2,200	2,200	2,200
Blood, washing-water, limewater lb.	517	838	330
Total pounds .	2,717	3,038	2,530
Products:			
Fat . . . . . . lb.	243	163	—
Meat-meal . . . . . ,,	436	739	—
Liquid extract . . . . ,,	2,024	2,018	—
Liquid in fat . . . . ,,	—	110	—
Total . . .	2,703	3,030	—

of the apparatus is made, which is mounted on trunnions, permitting it to be tilted into an upright position, and instead of the man-hole, the whole of one end is formed into a removable cover so that the carcase can readily be lowered into the cylinder without handling. This modified arrangement is illustrated in Fig. 28.

In Germany, strict guarantees are exacted for all machinery of this sort, and severe tests are made to ascertain if the apparatus gives results in conformity with the guarantee. The Table on this page is an example of such a series of tests, and the analyses of the products are of considerable interest.

Analyses of Meat Meal from Podewils Apapratus

Date.	3/4/08. Per cent.	10/4/08. Per cent.
Nitrogen	7.16	6.29
Phosphoric acid . . .	7.61	4.54
Water	5.49	9.33

TREATMENT OF RESIDUAL PRODUCTS IN ABATTOIRS AND MEAT-PACKING ESTABLISHMENTS

In the treatment of blood and such residues the revolving drum apparatus previously described, is much in vogue in Europe, but the separation of fat may be also accomplished in a different way, so as to bring the operation within the sanction of local sanitary requirements.

One of the systems used for this process is known as the Wannenwetsch Combination Sanitary Rendering and Drying Apparatus and is made in America. It is claimed for this particular process that, if compared with the system of rendering, which in an American packing-house usually consists of a rendering tank, fertiliser press and fertiliser drier; it requires less space, labour, and smaller cost of maintenance, than is necessary for this triple system. The Wannenwetsch system requires only one handling of material, such as is derived from slaughterhouses in the way of offal, tallow, bones, butchers' scraps, blood and diseased animals, or condemned meat. The plant consists of a vertical three-quarter steam-jacketed rendering tank of dimensions suitable to the quantity of material to be handled and an air-pump with steam-engine, so as to provide an exhaust and accelerate evaporation. Should there be more than one tank in operation, a large engine and exhaust pump can be applied to a number of different units and in this way save a large amount of labour. In the illustration accompanying, there is represented a three-unit system with a total capacity of nine tons at one charge, and this material may consist of any kind of residual matter, such as has already been mentioned. The advantage of the system is that any unit or rendering tank can be operated independent of the others.

The material to be rendered is placed in the rendering tanks through the upper man-holes which are provided on the top of each tank, and the apparatus (as illustrated in Fig. 29) is charged to within 18 in. from the top, after which the man-hole is sealed up, a by-pass valve is opened and this leads into a larger outlet pipe, through which the vapours are drawn through the apparatus by means of a vacuum pump and are delivered into a gas-collecting compartment, where the condensible gases are condensed by means of a water spray or jet condenser, and the non-condensible gases are then passed on to be consumed by the furnace fire of the boiler.

Direct steam is admitted into the apparatus at four different points close to the bottom, and the result is that the rendering is performed with uniformity and great speed, as there is an agitating gear in the apparatus. The material is quickly and constantly brought in contact with the steam and the result is, that in from three to six hours the cooking is complete. When this is accomplished, the fat is drawn off by outlet taps which are fixed in the side of the apparatus and, as there is also a large quantity of liquor present, this is drawn off also. The steam is then admitted to the jacket of the apparatus and the agitating gear is kept operating, as is also the vacuum pump, the drying being done under a high vacuum, which has the result of preventing loss of ammonia. The evaporating takes place at a low temperature, consequent on the production of a vacuum. The material can be examined at any time by means of an inspection valve and when a sufficiently dry state has been reached, the lower man-hole of the apparatus is opened and the product is discharged into receiving vessels of any kind which may be found convenient.

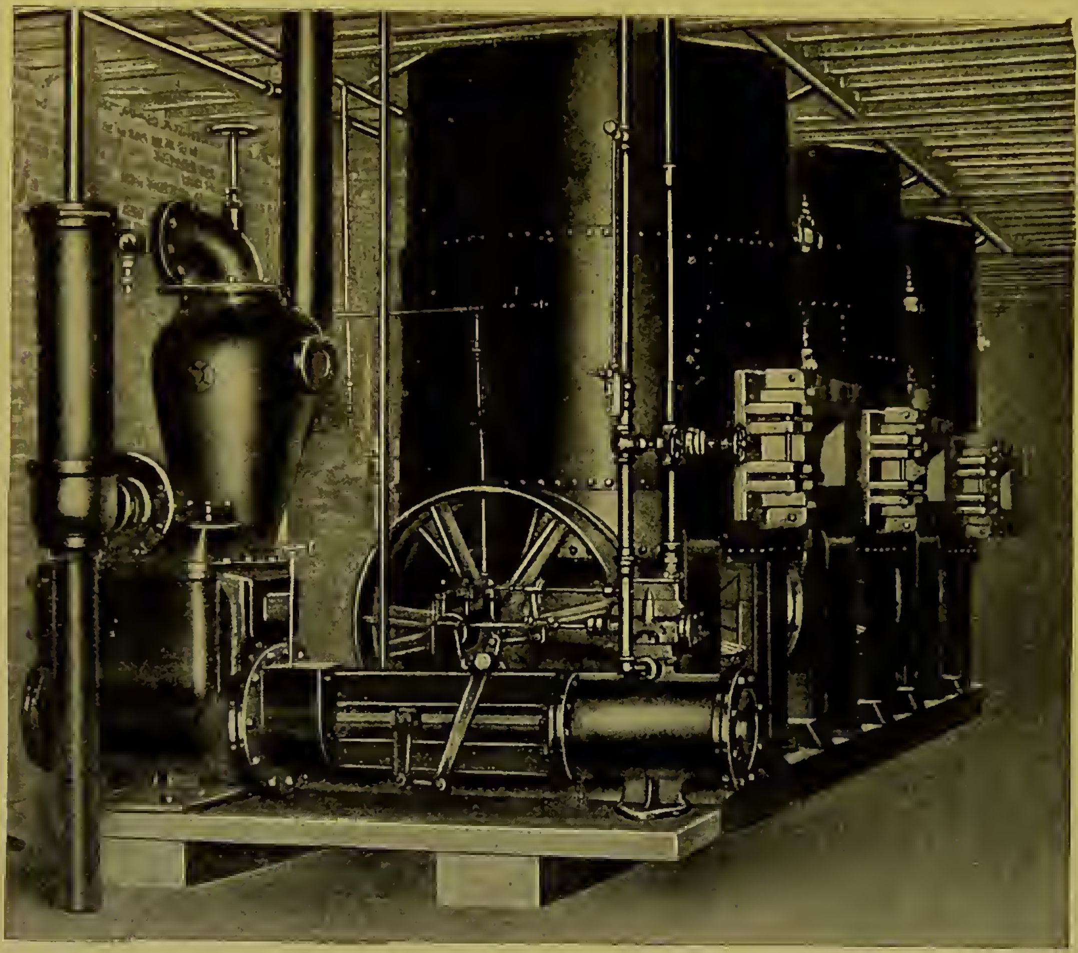


Fig. 29.—Plant for Utilisation of Packing-house Residues
It is worked on two floors, the residues being loaded into the tanks from the upper floor, through man-holes provided for the purpose. The illustration shows the lower floor.

By means of this system the ordinary operations of separating, pressing and drying of tankage are eliminated, together with the necessary tankage presses and separate fertiliser driers, and there is no doubt that it presents features of a highly economic character as compared with other systems.

CHAPTER X

PRESERVED PROVISIONS

THE method of preserving food by sterilisation, or the application of heat to the articles after packing them in air-tight vessels, was discovered by Nicolas Appert, in the beginning of the last century, and he has not inaptly been called the father of the preserved provision industry. In 1809, stimulated by the offers of rewards made by La Société d'Encouragement pour l'Industrie Nationale for discoveries from which the nation and humanity might draw substantial benefits, and by the appeal of the Agricultural Society for information on the best means of preserving alimentary substances, he made public the process in which he had been experimenting for ten years. It had been so successful that he could exhibit provisions, in perfect condition, that had been preserved for six years. The matter attracted the attention of the French Government, who had the process investigated by the Board of Arts and Manufacturers, with such satisfactory results that the Minister of the Interior awarded M. Appert 12,000 francs, the sole condition being that he should publish an account of his discovery.

Appert had been engaged for forty-five years in the preserving of provisions by the accepted methods, and states very clearly the objections, from the dietetic point of view, to the excessive use of salt in the preservation of meat and vegetables, and of sugar in fruit and fruit syrups. There was the further objection to the latter that the political situation and the national aspirations made it necessary to live, as much as possible, on domestic produce, and to discourage the use of imported goods. Then the Government wanted to avoid the use of salted provisions in the Navy, and thus everything conspired to give a warm welcome to Appert's discovery.

Appert's Process Summarised. The following is Appert's summary of his process:

"(1) In enclosing in bottles the substances to be preserved.

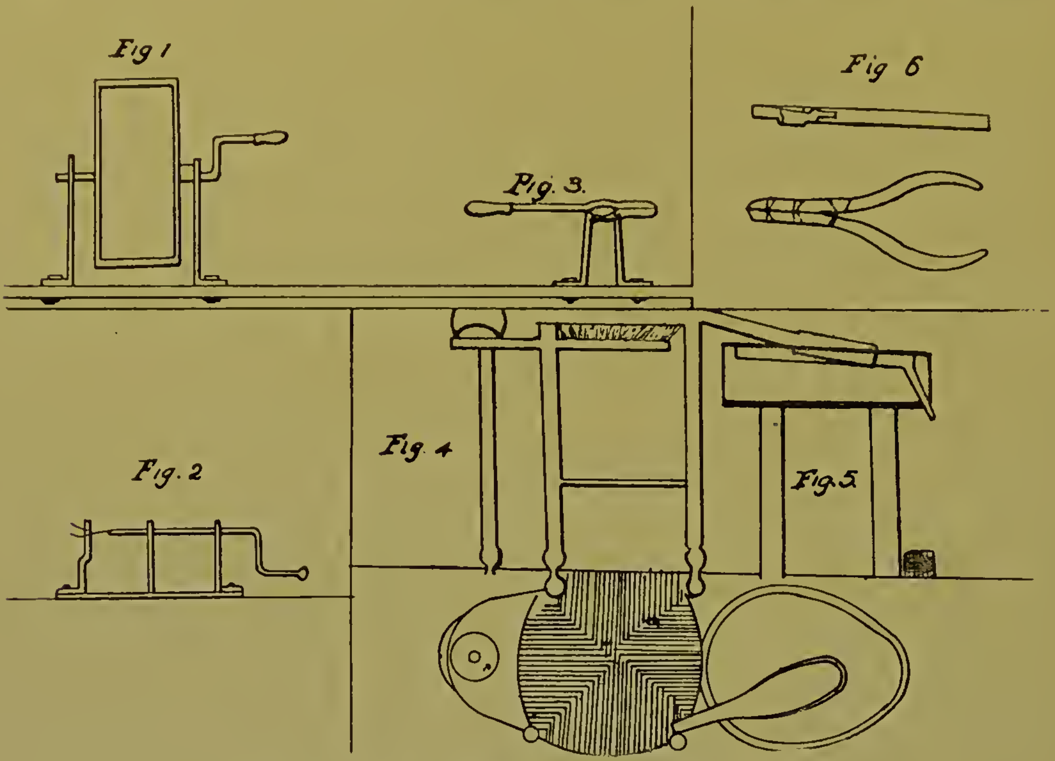
"(2) In corking the bottles with the utmost care, for it is chiefly on the corking that the success of the process depends.

"(3) In submitting these enclosed substances to the action of boiling water in a water-bath (Balneum Mariæ), for a greater or less length of time, according to their nature, and in the manner pointed out with respect to each several kind of substance.

"(4) In withdrawing the bottles from the water-bath at the period prescribed."

The detailed account shows a thorough grasp of the practical principles of sterilisation, and no improvement on it, except in machinery and details, has taken place to the present day. It would now be known as "bottling," as distinguished from the larger modern industry of "canning" or "tinning."

We reproduce from the English edition of Appert's book published in 1811, a plate of the tools he employed, and his description of them.



ILLUSTRATIONS OF THE TOOLS EMPLOYED BY APPERT

DESCRIPTION

FIG. 1.—A reel with two iron bars, made use of to double the wire and cut the doubled wire twice the length required for fixing the corks in the bottles.

FIG. 2.—A small machine for twisting the wire one-third of its length after having been doubled by Fig. 1.

FIG. 3.—An instrument for compressing (and, as it were, biting) the corks three-quarters of their length, beginning at the smallest end.

FIG. 4.—A stool stuffed with straw, furnished with a wooden stand on which the bottles may be placed to be tied. The same stool will serve to sit on during the corking.

FIG. 5.—A hollow block of wood, called a bottle-boot (Casse-Bouteille), within which the bottle is set when it is to be corked. This bottle-boot is furnished with a strong bat for beating in the corks.

FIG. 6.—A front and side view of pointed pincers, used for twisting the wire employed to keep in the corks and for cutting off the superfluous ends of the wire. Appert made use of flat pincers and scissors for this operation.

The discoverer's explanation of the process is worth reproducing for, although many years had yet to elapse before the true theory could be stated, Appert's account, so far as it goes, shows an exact appreciation of the conditions :

"(1) That fire has the peculiar property, not only of changing the combination of the constituent parts of vegetable and animal productions, but also of retarding, for many years at least, if not of destroying, the natural tendency of those same productions to decomposition.

"(2) That the application of fire in a manner variously adapted to various substances, after having with the utmost care and as completely as possible, deprived them of all contact with the air, effects a perfect preservation of those same productions. with all their natural qualities."

As we have seen in the chapter on refrigeration, the real explanation is supplied by bacteriology. The application of cold preserves perishable articles of food by preventing, or hindering, the development of the bacteria which produce decomposition. In the process of sterilisation all the bacteria decomposing organisms in the food to be preserved are killed by the application of heat, and the containing vessels being air-tight, no further germs can be introduced from the outside atmosphere, which swarms with them.

The prolonged application of heat, which forms part of the process of preserving, after the can or bottle is hermetically sealed, is practised so as to destroy the spores of bacteria, which may be present.

Different Methods of Meat Preservation. The preserving of meats is carried out by means of:

(1) Cold storage.
(2) By drying or desiccation.
(3) By the use of chemical preservatives.
(4) By the exclusion of air, or canning.

Meats are very rarely preserved for any lengthy period in glass moulds or bottles, although there is a considerable trade done in ox tongues and brawn in glass moulds. It is found, however, that after a period of some months, there is considerable liability to decomposition in goods preserved in this way, attributable to the fact that in the process of preserving, all the spores have not been destroyed.

Methods of Canning. Canning is the process which is universally carried out, and may be conducted in two different ways.

The canning process may be carried out by the aid of canning vats, which are simply rectangular open tanks, which have a steam coil all over the bottom, upon which a perforated plate is placed. A calcium chloride solution, having a density of 100° on the Douglas salinometer, is placed in the canning-vat, and the quantity of this material is regulated entirely by the depth of the tins to be used for canning. The various sizes of the tins used in connection with the business are as follows:

1 lb. size	$2\frac{3}{4}$ in. diam.	× 4 in. high.
2 ,, ...	$3\frac{7}{16}$,,	× $4\frac{9}{16}$,,
3 ,, ...	$4\frac{3}{16}$,,	× $4\frac{7}{8}$,,
10 ,, ...	$6\frac{1}{4}$,,	× 7 ,,

In the heating of these tins in the canning-vat, the calcium chloride solution should reach three-quarters way up the sides, and the time for cooking should be regulated strictly by the size of the tins, increasing by fifteen minutes, which is all that is necessary for the small tins, up to two hours for the largest.

The calcium chloride solution is rather apt to evaporate, hence it is necessary to place in the vat a quantity of lard or fat, which swims all over the surface, and thus retards evaporation.

After the cooking process is complete, the tins are fished out, and plunged into cold water, and then immediately into dry sawdust, so as to cleanse them and make them free from fat and water.

Sometimes the process is carried out by means of crates, which are lifted bodily out of the canning-vat, so as to expedite the work.

When the tins have been removed and dried, they are then ready for lacquering, and afterwards can be labelled.

The unsoundness of the tins is evidenced by their bulging out at either end, which shows that there has been an expansion of gases inside, causing the tins to be forced out, but this feature may not appear for some days. When the tins exhibit signs of this sort, they should be condemned at once.

In cooking the tins, it may be generally stated that the material, such as meat products, which the tins may contain, should always be previously cooked in open pans and added to the tins in this condition. The cooking process in the canning-vat is therefore directed to the destruction of bacteria which may be present, and the process is as follows :

The tins are headed up and closed entirely, and then placed in a bath of calcium chloride solution, reaching three-quarters way up the sides, and at the end of the time determined necessary for the size of the tins being cooked, they are removed, and a small puncture hole made in each tin at a recognised place, where there is a lip of tin soldered inside the cover. On making this puncture hole, air, and a certain quantity of steam, will be discharged, and as soon as this has taken place the puncture hole is covered with a little solder, and the tin sealed up again.

Cooking by the Canning Process. The tins are then immersed totally in the calcium chloride solution, and allowed to remain for a certain period, according to the article handled, which time may be gathered from the table on page 655

Sometimes the tins are immersed altogether in the calcium chloride solution at the first cooking, and as they are closed, there seems to be no reason why this should not be done. It is also common to take the tins after they have been cooked in the canning-vat, and place them in a retort, so as to cook them by steam, as the final process.

The Retort Explained. The retort * is on the same principle as the autoclave which is extensively used in French canning establishments. It has of late years almost entirely superseded the wet-bath process for the higher temperatures. It is a single-jacketed steam chest, capable of working up to 50 lb. steam pressure on the square inch, is rectangular in shape, and may be made to suit requirements. About 48 in. × 48 in. × 72 in. deep is a fairly large size and can accommodate most goods. The cans to be heated are packed in trays and the wet steam turned on until the temperature reaches 270° F. In some places the temperature is not allowed to reach a higher point than 240° F., but according to our present knowledge, this does not suffice to destroy the spores of certain bacteria.

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* *Douglas' Encyclopædia*, p. 177.

TABLE GIVING TIME REQUIRED FOR COOKING VARIOUS PRODUCTS BY THE CANNING PROCESS

Name of Goods.	Time required to discharge all air, temperature of bath being 212°.	Time required to further cook in bath after closing puncture, temperature of bath 212°	Time required in retort, temperature 240° Fahr.*
	Minutes.	Minutes.	Minutes.
Fruit: Apples	6	12	4
Apricots	6	10	4
Blackberries	5	10	4
Cherries	6	10	5
Currants	6	10	5
Gooseberries	6	10	5
Grapes	5	10	5
Nectarines	5	10	5
Peaches	5	10	5
Pears	5	10	6
Pine-apple	12	15	10
Plums	6	10	6
Raspberries	5	5	3
Strawberries	3	6	3
Whortleberries	5	10	5
Vegetables: Asparagus	10	—	35
Beans	10	—	40
Peas	12	—	25
Potatoes	5	15	6
Tomatoes	10	20	15
Fish: Crabs	10	—	10
Lobsters	10	—	20
Oysters	10	—	20
Sardines	—	—	15
Soups: Hare	5	—	20
Mock turtle	5	—	15
All other soups	5	—	20
Meats: Beef, mutton, &c., according to size of can from	15	—	20
to	30	—	50
Sausages (put in tins uncooked)	30	—	20
Pork pies (already cooked)	10	—	10

As the process is simply one of heating, the length of time will depend largely on the sizes of the tins, and in these matters a little practical knowledge is very easily acquired.

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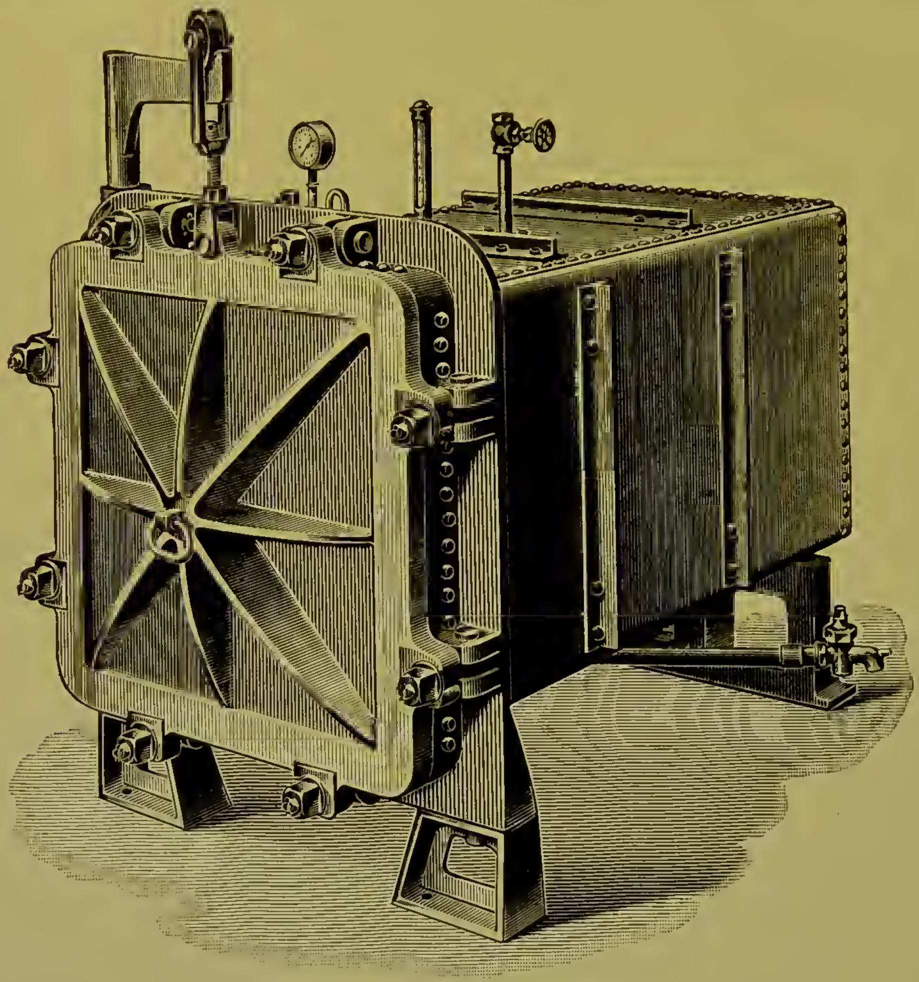
[*] The temperature stated is 240° Fahr., and this will be sufficient for most things, but it must be left to individual judgment when to increase this to 270° Fahr. so as to entirely destroy the spores.

With regard to the canning of such articles as vegetables, fruits, &c., these are all canned in the same way, but necessarily the length of time they are kept in the bath and in the retort is very much less. Fish also require special treatment. In the treatment of vegetables, blanching vessels are necessary, and there are many special devices which are needed where very extensive work is carried on.



Preserved-provision Retort

Goods that are Tinned. The various goods that are tinned in large quantities are:

Beef.
Mutton.
Brawn.
Sausages.
Pork pies.
Hams.
Bacon (in rashers for Army rations).
Fowl and all kinds of game.
A great variety of fish.
Vegetables of all kinds.

The "process," as it is called, is sometimes carried out as follows:

The article to be canned is placed in the tin usually after being cooked, and in the case of meat substances the spaces are filled up with jelly or fat according to the nature of the commodity. The lids are soldered on, perfectly, after noting that a puncture hole is free in the centre of each. The tin is then placed in the canning-vat, being immersed to about three-quarters of its depth in the calcium chloride brine. The brine is now heated to 212° F., and the tins are kept at that temperature until, on wiping the puncture hole with a cloth, no more moisture or steam appears to be issuing. This should take about ten to fifteen minutes. Immediately thereafter, drop a little solder on the puncture hole of the lids, and so seal them up. Now increase the steam pressure until the temperature rises to about 270° F. At this temperature the spores in the meat are destroyed. The length of time at which this temperature may be continued depends on the size of the tin. For a 1-lb. tin the time required is about ten minutes.

Soldering appliances as well as tin- and can-making apparatus, both for hand and steam power, are made very extensively, and it may be quite easily understood that in an industry which involves many millions of pounds' worth of products, in the United Kingdom alone, there are likely to be many mechanical devices, so that the turning out of the tins, the soldering and lacquering, can be done very expeditiously in a mechanical way.

The following notes are by an experienced canner.

In writing on the subject of canning, it is taken for granted that those likely to read these notes have at least some slight knowledge of the subject, also of the curing and handling of meats, and will therefore be able to intelligently follow them, without its being necessary to enter closely into all the lesser details. The "Secrets of Canning," as they are usually termed, are no very great secrets, although apparently guarded as such by each canner, who has a natural objection, and justly so, to his own particular methods—which through his time and attention he has developed in his own peculiar manner, and probably perfected in such a way as to make his brand of goods a reliable one on the market—being surreptitiously carried away from him.

A GUIDE TO SUCCESS IN CANNING

In England, canning is not as yet taken advantage of to the extent that it might be, or its possibilities grasped, when it is taken into consideration how it might be advantageously dealt with. The canning of fish, fruit and meat products in other countries, where supplies are plentiful, has assumed vast proportions, and the products dealt with will be found generally useful in many quarters of the globe.

It is not intended here to go into all the details of estimates of buildings, plants, &c., the object aimed at being rather to give clearly and concisely the system of putting up canned goods of the various descriptions which have already a good market value, and to describe the methods by which, with a little ingenuity, materials not included in this article may be adapted to the canning process.

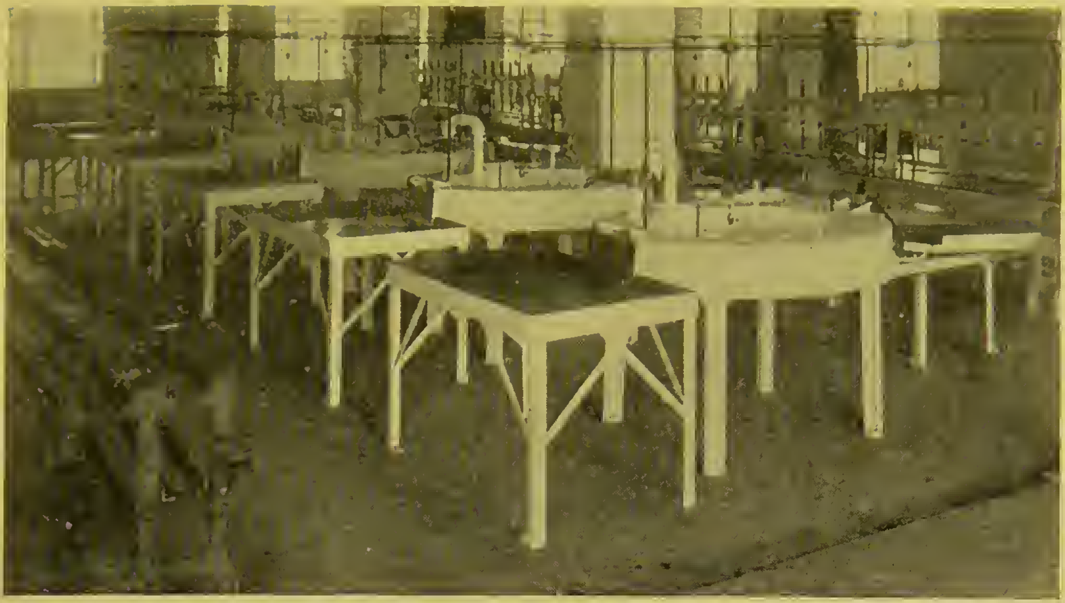
It might be well to state that the first requirements towards success are absolute cleanliness and vigilant personal supervision of all the various articles to be brought into use. The best policy, and the most economical in the long run, will be at once to reject as quite undesirable anything that may be in the least suspicious of not being in perfect condition, than after having put it through the various processes, to have in the end to reject it, thus adding useless labour and tins to its cost, as well as running the risk of getting the brand into bad repute. The canning trade is one of such importance, while charges are sometimes laid to its door on very slender and mostly unfounded grounds, that it behoves every canner to see that no attempt is made to put anything on the market that would tend to destroy public confidence. No incompatibles should be added to the primary articles which might impair the keeping qualities.

We are leaving out glass dishes, as not coming within the scope of these notes, and will confine the hints to hermetically sealed cans.

The cans or tins can be had in any shape or size to suit the goods or the fancy of the packer. They can be bought ready made from any of the various makers, or probably, better, can be made on the premises by putting in the necessary machinery, in the shape of presses, dies, &c., this latter method effecting a great saving over the first, in carriage and packing-cases—empty cans making very bulky packages. To those who prefer the first method, it might be found a suitable plan to have boxes made at the can-making establishment to hold the number of tins as they will go on the market after they are filled with their contents; at some can-making factories they do this for their customers. All cans should have their joints soldered from the outside, as the outside soldered can is taken up with more confidence by the public; if a can with any of the patent key openers is used, the can must be carefully investigated, as there is a risk in those that are lined where the tin cuts open with the winding of the key, of rust eating its way through the lined mark, when the tin and its contents are ruined.

In preparing meats for canning which first require to be put through the process of curing, each curer will in all probability prefer to use his own methods. A word of caution, however, might be given here, to use only the minimum amount of salt, saltpetre or antiseptic, as the case may be. In cooking meats for canning, copper pans are not recommended by the writer as being suitable for this class of work, for if the tinning gets worn off, which it unfortunately will, it has a tendency to discolour meats, so as to quite spoil their appearance; iron kettles or wooden tanks or tubs, with a steam coil in them, are recommended instead.

Labels are a matter of individual taste, but the selection of an appropriate label is worthy of the greatest consideration, and of late years so much importance has been given to this matter that labels have reached a high standard of artistic excellence. A good label on an inferior article will not make the article good, but a really first-class article should have the best label that the profits will reasonably allow. In choosing a label the lettering should be reduced to the lowest possible limits, and prominence given to some object in the design which will catch the eye and be remembered; retailers will always give a good labelled can a prominent place in their windows or on their counters.



Vacuum Machines for making Cans Airtight

Lacquer. It will pay well to get quotations for this article from several good chemical firms, as there is a very wide divergence in the prices asked for the same quality of lacquers. It can be obtained to be applied to the cans either hot or cold ; the cold will be found to be most suitable for general use. The cans should be clean and quite free from grease before applying the lacquer, and this should be seen to by having them wiped as they come from the retort. If any of the cans are found to be greasy or dirty after cooling, a good way to clean them is to have a few boxes of perfectly dry sawdust into which the soiled can is put and rubbed clean ; boys can do this rapidly, and get a good clean polished can, which will take the lacquer well.

Finishing and Testing Cans

Stencils are required to stencil the boxes or cases into which the cans are packed, and are easily procured, with designs, to suit requirements.

Processing. As the safest methods in canning pay best in the long run, it is our intention to describe as clearly as possible that which we have found by experience to be the most satisfactory for meats, &c. This has been proved to be the combination of the exhaust tank and retort process. The exhaust tanks are usually of rectangular shape, with a perforated false bottom, under which is a steam coil, carrying steam to heat the water, with which the tank is part filled, to boiling-point. The retorts are made in various shapes: some nearly square, some oblong; but it is a matter of much importance to test them before putting them to use, so as to make sure that they are set up properly, and that the internal steam-heating coil or coils are so arranged that in discharging their steam they do not set up vibration in the retort. If there is vibration during the process of cooking, such articles as brawn, &c., will separate the jelly from the solids, leaving one half of the can filled with jelly, and one half with the chopped meat; a consummation not to be desired.

A Safe and Easy Method. The caps or lids of the cans should be perforated by one small bradawl hole, termed "the vent." Underneath the vent, on the inside of the cap, there should be a small cup-shaped piece of tin, attached to the cap by one or two drops of solder, in such a way as to allow the can to exhaust all air, but to be able to catch and retain hold of any loose solder that might find its way through the vent, and thus prevent its getting into the meat. The can having been filled with its contents, it is now capped, that is, the cap or lid is soldered on and the vent-hole stopped with a drop of solder, as soon as enough cans are capped to be sufficient for a cooking. The processing begins with the exhausting, and it is well to do this important part of the work in a fairly warm room, with doors and windows closed, so as to prevent draughts. The cans are put into the exhaust tank, covered with water, and the water brought to the boil (212° Fahr.). The length of time they are to remain in the boiling water depends upon the size of the cans. Cans up to, say, 3 lb. are allowed twenty minutes, after which they are removed from the exhaust tank, placed on the bench, where the solderer is prepared with everything in readiness, and he immediately with his hot bolt proceeds to wipe the drop of solder off the vent with which it had previously been stopped, when the can at once blows or exhausts itself of the air, which comes out with the steam generated by the boiling, when the vent is closed. Whenever the can is exhausted, the vent is again stopped with solder; this part of the process requires the greatest care, and much of the success or otherwise depends on the thoroughness with which it is accomplished, but with practice it can be done very expeditiously. The can is now ready for the retort, into which it is placed. The purpose of the retort is to subject the cans to a greater heat, which is more easily obtained under steam pressure than in the open tank: partly to complete the cooking of the meats, and partly to subject the contents to a heat of sufficient temperature to penetrate quite through the contents and destroy any destructive germs that may be contained therein. The cans can be cooked in the closed retort either by the wet or dry steam process ; the dry process is to use the steam only, and care must be taken with this process or a burnt flavour may be imparted to the goods ; the wet process is to place the cans in the retort, then fill about three parts with water. The retort should be provided with a steam-pressure gauge and a thermometer, also a blow-off cock. When the retort has been filled sufficiently, and the man-hole or door securely bolted, the steam may be admitted, with the blow-off cock left slightly open, until the thermometer registers about 212° Fahr., when it should be closed perfectly tight and the pressure raised to 12 lb., which is equal to about 240° Fahr , and from this point the cooking, up to 3-lb cans, should be continued for twenty minutes. Then turn off the steam and open the blow-off cock so as to exhaust the steam. The retort is then opened and the cans taken out and showered with cold water from a hose, sprinkler, or any suitable apparatus, and put away on racks until thoroughly cool. The tops and bottoms of properly processed cans on cooling will pull inwards towards the vacuum caused by exhausting, while in a short period of time those imperfectly processed, or badly soldered, will bulge the ends out, better known as "blown" tins. This completes the processing, and they may now be stored away, ready for the finishing touches, *i.e.* lacquering and labelling.

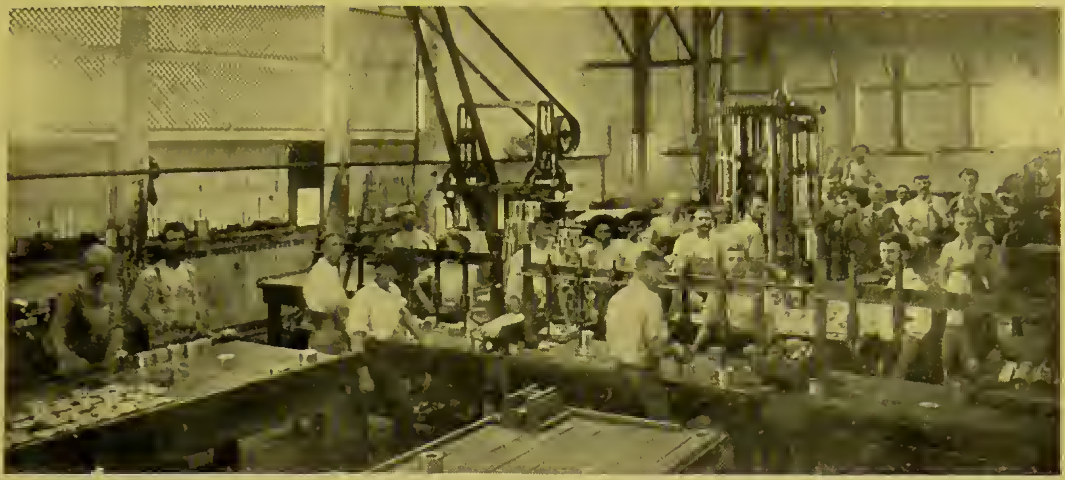
The Calcium Chloride Process. The foregoing is a proved method, safe and easy to carry out ; but there may be some who desire to make use of the calcium chloride bath, and specially designed open tanks for this process can be had of any size to suit requirements, but are usually 20 in. deep. By the calcium process, the cans are generally exhausted with the vents open, care must accordingly be taken that the water in the tank in which the cans are immersed must not be allowed to cover the cans, but only reach within, say, half to three-quarter inch from the top. When the necessary quantity of water to do this is arrived at, the solution is prepared by adding to each gallon of water 3½ lb. calcium chloride, which will give a liquid that will boil at a temperature of 225° Fahr., the cans are exhausted in this bath, the time being taken from the moment that the steam begins to issue from the open vents of the cans. Allow fifteen minutes for 3-lb. cans, after which the vents should be closed while the cans are still in the calcium chloride bath. They are then removed from the bath and the processing completed in the retort, as in the first given process.

The principal items of plant required are as follows : the steam kettles, or steam-heated tanks, which are utilised for the first parts of the process, such as cooking, blanching or scalding. Then after packing or filling of the cans, either by hand or special can-stuffing machinery, the cans are capped, *i.e.* the lid is filled and soldered, the requirements for this being soldering irons, anvil for shaping up irons, and vice for holding irons while being filed up for tinning, hammers, files, solder fluid,

THE LABELLING-DEPARTMENT IN THE MEAT EXPORT WORKS, QUEENSLAND

THE PRESERVING-ROOM, SHOWING THE RETORTS, IN THE MEAT EXPORT WORKS, QUEENSLAND

THE WASHING-MACHINE IN THE PRESERVING-DEPARTMENT OF THE MEAT EXPORT WORKS, QUEENSLAND



Preserving-room in the Meat Export Works, Queensland

The Trimming-room in the Canning-department

Soldering Tins in the Canning-department

&c. In exhausting the air from the cans by means of the exhaust tank, tongs or hoop-iron crates are required to lift the cans out of the exhaust tank. If hoop-iron crates are used, a crane or set of pulley blocks may be required. The retort is for the final process, and a trolley may be found useful for moving the cans about; it will also be necessary to provide buckets, knives, thermometers, weighing-machine, scales, &c. Braziers will suggest their own proper uses.

Corned Beef is an article which is in large demand; it is put up in 1-lb., 2-lb., 4-lb., 6-lb. and 14-lb. cans. The method of preparation is as follows:

The beef is thoroughly cured in suitable sized cuts, with bone left in; it is important to have the meat thoroughly cured throughout, as uncured parts will cook dark and make the appearance unsightly in the finished product. When the curing and all the necessary preparations are complete, it is taken to the cooking-department and cooked till the bones can be easily withdrawn from the meat; it is then quickly, and before being allowed to cool, chopped by hand (not machine) into squares, according to the size of the can into which it is intended to be filled, as for example; for 1-lb. cans, pieces as nearly as possible in ¾-in. squares; 2 lb., 4 lb. and 6 lb. in 1-in. to 1½-in. squares; and 14 lb. in 2 in. or over. It is then packed tightly into the cans and weighed, and the cans capped up. To this point the work should be proceeded with as rapidly as possible—as the meat will pack better while warm. The can being now capped and soldered is ready for processing, and after processing the meat will cut practically solid.

Fresh Beef is prepared in a manner similar to corned beef, minus the curing. It is recommended, however, that a little salt be added to the water in which it is boiled. The demand for fresh meat in cans is not so good as for the corned beef, and it would be considered advisable for the prospective canner to look round for his outlet, and find out the probable size of can most likely to suit requirements; the 2-lb. can will, in all probability, be found the most useful for this article.

Potted Beef can be satisfactorily prepared with fresh, roasted or boiled meats—roasted for preference, on account of the superior flavour to be obtained by the roasting, cooking by roasting retaining more of the natural juices of the meat than boiling. After having been thoroughly cooked and freed from all bone, gristle, &c., the meat is chopped or pounded into a fine paste, salt, pepper and seasoning to taste being added during the process of chopping, and it is then packed into 10-oz. cans.

Roast Beef is roasted in as large pieces as can be conveniently done with the ovens available. When sufficiently roasted it is boned and spice added, and it is then treated by the same methods as corned beef. For a superior brand choice cuts of a large size should be selected, sprinkled over with salt, seasoning and spices, well roasted and packed in rather flat or shallow cans; a whole piece to each can.

Mutton is put through the same process as beef, but if cured should not be allowed more than twenty-four hours in pickle.

Ox Tongues "Whole." The tongues are first subjected to a mild pickle not over 70° on the Douglas salinometer, and allowed about twenty-five days to pickle. When they are cooked, the wing bones removed and skin peeled off, the tongues are sorted out according to sizes and packed in cans, weighing 4 lb., 3½ lb., 3 lb., 2½ lb., 2 lb. or 1½ lb., and processed.

English Brawn. This is manufactured from pigs' heads. If the heads are inclined to be fat, additional lean pork must be added, as over-fat brawn is quite unsaleable. The heads are boned when fresh, and cured in a mild pickle for about fourteen days, and when cured they are placed in the steam kettle with enough water to cover them, and the water brought to the boil; they are then boiled till about three parts cooked, when the meat is taken from the liquor and chopped into pieces about ½ in. square, and put on one side. While this operation is being performed the liquor is kept boiling, and there should be added to it any spare rinds or a few pigs' feet to help to make a strong jelly; if those are not available, a little gelatine may be used instead. When the liquor is condensed to the right proportions for the amount of chopped meat—about half and half—the fat is carefully skimmed off the liquor, and the liquor drawn from the kettle into buckets; the kettle is then wiped out clean and the liquor poured back into it through a hair strainer. The chopped head meat is now put into the liquor, and seasoning added in the proportion of ¼ oz. ground nutmeg and 1 oz. ground white pepper to every gallon, and well stirred into the mass. The brawn is then weighed into the cans, and processed in the same way as cooked meats.

Cambridge Sausages. The fresh sausages are made in the ordinary way, with any special seasonings that may be the fancy of the makers but with this distinction, that for canning purposes they should contain meat only. On being filled into the casings, they should be weighed into lengths of 12 oz., linked into six links of equal length, placed evenly in the 1-lb. can, and the can filled with 4 oz. of prime sweet lard. The can is then capped and processed.

Time Allowed for Processing the Cans of various Sizes. The preceding being, with the exception of the sausages, all made with meats well cooked before going into the cans, do not require very long time in processing. The following will be found sufficient for all cans of the sizes given below unless specially mentioned:

Size of cans.	Length of time in exhaust pan.	Length of time in retort.
5 oz. to 10 oz.	10 mins. (212° F.).	10 mins. (240 F.).
1 lb. ,, 2 lb.	20 ,, ,,	20 ,, ,,
3 ,, ,, 4 ,,	25 ,, ,,	30 ,, ,,
5 ,, ,, 6 ,,	30 ,, ,,	35 ,, ,,
14 ,,	35 ,, ,,	45 ,, ,,

Minced Collops. Take 70 lb. lean fresh meat, from which all sinews and fat have been carefully removed, 7 lb. good beef fat (*not suet*), 30 lb. beef hearts, which have been well cleaned from all blood, and stringy parts removed, 4 lb. corn flour, 2 lb. onions (peeled). Ascertain that the knives in the chopping-machine are in perfect order, so as to cut clean. The meat must on no account be stringy when chopped. Place all the above material in the chopping machine and chop fine; remove from the machine and place in steam-jacketed kettle; add 3¼ lb. fine salt, 13 oz. ground white pepper, and 15 lb. previously prepared clear jelly liquor; simmer gently for thirty minutes, stirring well to keep from burning; dish out and weigh into 2-lb. cans, and process.

Soups. The basis for good soups is always at hand in a meat-canning establishment, in the shape of bones, meat scraps, &c., which should be boiled down while fresh, also the liquor in which tongues and meat have been boiled can be utilised, by evaporating down to a good strong solution, skimming off the fat and straining it through a hair strainer. Attention to this will be repaid by producing a very good and desirable soup stock.

Mulligatawny Soup. For this soup the following vegetables are required (these should be fresh and free from any decay): carrots, 70 lb.; white turnips, 25 lb.; leeks, 15 lb.; onions, 15 lb.; lettuce, 12 lb. The carrots and turnips are scraped, trimmed, and cut up neatly into small dice-shaped pieces, the leeks and lettuce are also trimmed and chopped into small neat pieces, the onions are peeled and sliced thin. Put them into the kettle and add 60 gallons good, concentrated soup stock, as previously described, 3 gallons mushroom catsup, 1¼ lb. white pepper, 5 oz. curry powder, 4 oz. ground mace, and 4 lb. fine salt. Simmer gently for forty-five minutes, then put through a strainer, so as to collect and separate the vegetables for accuracy in weighing; the vegetables are dished into 2-lb. cans, 6 oz. to each can, and the soup stock is then added to weigh 2 lb. 1 oz. The cans are then capped and processed.

All soups require 1 oz. overweight of soup stock, to allow for shrinkage.

Julienne Soup. The vegetables required are: carrots, 90 lb.; leeks, 25 lb.; celery, 25 lb.; onions, 25 lb.; white turnips, 25 lb.; lettuce, 10 lb. The carrots must be scraped clean, trimmed, and cut into pieces about 1 in. long and about the thickness of straw, the leeks and celery cut into small squares, the onions sliced into very thin slices, and the turnips, and lettuce chopped up very fine. When the vegetables are prepared, put the lot into the steam kettle, and add 40 gallons concentrated stock, also mushroom catsup, 2 gallons; ground white pepper, 1 lb.; mace 3 oz.; fine salt, 7 lb. Simmer gently for thirty minutes, strain through sieve to separate vegetables, and into 1 lb. cans put 3 oz. vegetables, then fill with stock to make 17 oz., and process.

Chicken Soup. After chickens have been plucked and singed, they must be washed in at least two changes of quite cold clean water to remove blood; they are then cooked till tender enough to allow the bones to be pulled from the flesh. The meat is then chopped into small pieces by hand, the stock in which they have been boiled is strained, the fat skimmed off, and evaporated down to half its bulk. To this is added enough concentrated soup stock to make 23 gallons. Into sufficient cold water, in a convenient basin, sift 20 lb. best corn flour, stirring all the time, so as to get a nice thin batter, free from lumps ; add this batter to the soup stock very slowly, constantly stirring ; then add in the same manner 7 gallons of good fresh sweet milk, which has been previously boiled and allowed to cool ; season by the addition of ground white pepper, 1 lb ; fine salt, 2½ lb. ; curry powder, 3 oz. The soup must be slowly simmered for forty-five minutes, constant attention being paid, to the stirring, so as to prevent burning. Prepare enough good clean rice by boiling for at least two hours, and then into each 1 lb. can weigh 3 oz. chopped chicken meat, 1 oz. boiled rice, and prepared soup enough to make 17 oz. ; into 2-lb. cans 6 oz. chicken, 2 oz. boiled rice, and soup to make 2 lb. 1 oz. Cap and process in the usual way.

Ox Tail Soup. The tails should first be soaked for fifteen to twenty minutes in clean cold water to draw the blood ; they should then be jointed and cooked in steam kettle, with just enough water to cover them, until tender, when all the meat is removed from the bones. This being done, the liquor they were cooked in should be drawn off and strained back again, and the fat well skimmed off. To this add enough soup stock to make 50 gallons, then take 10 lb. corn flour and sift into enough cold water, stirring constantly, to make a nice thin batter ; add this batter to the stock, with 2 gallons of mushroom catsup, 1 lb. ground white pepper, 4 lb. fine salt, 1 oz. ground cloves, 2 oz. ground nutmegs, 2 oz. ground corianders, 2 oz. cane sugar, and boil altogether gently for thirty minutes. Into each 2-lb. can weigh 4 oz. ox tail meat, and fill with soup to make weight up to 2 lb. 1 oz. Cap and process.

Bouillon Soup. For bouillon, glutinous parts of beef are most satisfactory—neck beef, shin and hock, heads and cheek meat, &c. The meat is cooked until tender, when it is chopped by hand into small pieces, and put on one side while the soup is being prepared ; the liquor, the meat was cooked in is strained through a hair sieve, the fat skimmed off, and evaporated to a third of its original bulk, and made up to 15 gallons with concentrated stock. Now add cayenne pepper, 1½ oz. ; mace, 2 oz. ; ground white pepper, 12 oz. ; ground corianders, 1 oz. ; salt 4½ lb. ; 20 lb. corn flour made into a fine batter, free from lumps, and 2 gallons mushroom catsup. Simmer slowly, stirring all the time to prevent burning, till the stock takes on a nice brown tint. Seventy pounds of good carrots should have been previously prepared, *e.g.*, scraped, trimmed and cut into small discs and small fancy-shaped pieces, and boiled for one and a half hours. Into each 2 lb. can weigh 5 oz. cooked meat, 6 oz. prepared carrot, add the soup to make up 2 lb. 1 oz. Cap and process.

Game, Fowl, and Ham. These lend themselves to easy manipulation in an almost endless variety of forms for canning purposes. In the potted form, the size of cans in most popular use are the 5-oz. and 10-oz. —the methods employed being in all cases similar, whether it be game, fowl, turkey, chicken, duck, tongue, beef, or any combination of equal parts of either, as for instance "Turkey and Ham," "Turkey and Ox Tongue," "Chicken and Ham," "Ham, Chicken and Tongue," "Chicken and Tongue," or "Beef and Ham." The procedure is to cook the article till tender enough to remove the bones (carefully remove all gristle), chop into a fine paste, which cannot be too fine, but which must have no stringy pieces in it. When it is in the chopping-machine suitable condiments should be added, to get a good palatable flavour, then pack into the cans, and cap and process.

Salmon. This is by far the most canned fish. The method is first to remove the scales, fins, entrails and heads; wash in clean lukewarm water, then about three parts cook the fish, without removing the bones. Cut into pieces proportionate to the size of the can intended to be used, pack into the cans, and fill same up with a brine made of water, containing 5 per cent. of salt.

Sardines. In some parts of the world these are put up from fish other than real sardines, though labelled as such. In Cornwall for this purpose the pilchard is used, in America young herrings, but the real sardine is the product of France and Portugal. There they are dealt with as expeditiously as possible, in fact, they are usually in the cans within twenty-four hours from the time they are caught. They are conveyed from the boats in baskets to the factories, where they are cleaned, the heads taken off, and the bodies dried, either by artificial heat or in the sun; they are then half-cooked in boiling olive-oil, taken out and drained free of oil, and neatly packed in flat rectangular-shaped tins, with the corners rounded. The tins are then filled with hot olive-oil and capped, and processed for fifteen minutes.

Oysters. Having procured the oysters, the first thing necessary is to have them opened. The most expeditious way to accomplish this is to have made a steam-tight case or box, heated by a perforated steam coil; the oysters are placed in this box, which should be securely closed, and the steam turned on for five or six minutes. This time should be sufficient to cause the oysters to open their shells; it is immaterial about losing the natural liquor, as the oysters will not keep good, preserved in their own liquor. They are now shucked, drained quite free from their liquor, well rinsed in clean cold water, and packed into 4-, 5- and 6-oz. cans. The can is afterwards filled with a brine of water, to which is added 5 per cent. of salt. Exhaust ten minutes and process fifteen minutes.

Lobster. This is usually put up in 1-lb. cans. Cook the lobsters about three parts, carefully remove the meat from the shell, breaking up the meat as little as possible, pack solid into the cans, fill up with brine of salt and water (salt 5 per cent. strong).

Fruits and Vegetables. In the canning of those the greatest of care must be exercised when processing, and the time watched keenly, so that the fruit may not be cooked so as to soften or make it pulpy. The fruit or vegetables must also be quite sound and free from any decay, and not over-ripe.

Apples. The apples are selected and graded so as to get them uniform in size, any over-ripe or decayed being rejected; they are then pared and cored, and packed as solid as possible into 3-lb. cans, and the cans filled with water. The cans are then capped and exhausted at a temperature of 212°, and processed for five minutes at 240° Fahr.

Pears. After being selected and pared, cut them in half and core; pack them in 2-lb. cans. The cans are filled with syrup, made up of pure cane sugar and water, in the proportion of 1 lb. sugar to each gallon of water, after which they are capped. Exhaust five minutes at a temperature of 212° Fahr., and process for five minutes at 240° Fahr.

Peaches. These are canned either pared or with the skin left on, cut in half, with the kernels removed, and packed into 3-lb. cans, filled full, syrup is added the same as for pears. The cans are then capped. Exhaust five minutes at a temperature of 212° Fahr., and process five minutes at 240° Fahr.

Pine-apples. These are packed after being selected, pared, cored and the eyes removed, either whole, cut in chunks, or grated, into 2-lb. cans; syrup is added, made in the proportion of 1¼ lb. pure cane sugar to each gallon of water. They are then capped and the cans are exhausted ten minutes at 212° Fahr., and processed ten minutes at 240° Fahr.

Plums. If the plums are moist they must be wiped over with a clean dry cloth, and any damaged ones rejected, the stalks are picked off, and the fruit packed into 2-lb. cans, with syrup added, made up of 1 lb. pure cane sugar to each gallon of water. Cap and exhaust five minutes at 212° Fahr., and process five minutes at 240° Fahr.

Apricots. These are not pared, but are carefully wiped and cut in half, the kernels are removed, and the fruit is packed fairly solid, syrup is added, made up of 1¼ lb. pure cane sugar to each gallon of water. Exhaust five minutes at 212° Fahr., and process five minutes at 240° Fahr. Pack in 2½-lb. cans.

Strawberries. Special attention must be given to this fruit, which should be sound and firm; pick off the stems, pack into 2½-lb. cans and fill with syrup, made up of 1¼ lb. pure cane sugar to each gallon of water. Watch the processing, which should not exceed: exhausting, three minutes at 212° Fahr., and the processing three minutes at 240° Fahr.

Gooseberries. This fruit should be well picked and have all leaves, &c., removed, packed into 2½-lb. cans, with syrup, made up of 1 lb. pure cane sugar to each gallon of water. The cans are then capped and processed—exhaust five minutes; process, five minutes.

Tomatoes. These are canned in immense quantities, and a well-put-up article is of good commercial value. The method of preparation is by first blanching or scalding the tomatoes sufficient to loosen the skins; this is best accomplished by filling into wire baskets, and lowering them into a kettle of water heated to about 160° Fahr. When the skins have loosened sufficiently for peeling, they are taken from the scalding water and peeled, and packed into 2-lb. and 3-lb. cans. The cans are filled with a brine made up of 5 oz. pure cane sugar and 5 oz. salt to each gallon of water. They are then capped and exhausted fifteen minutes at 212° Fahr., and processed twenty minutes at 240° Fahr.

Peas. After having been shelled, peas should, to save time, be sorted out by the machine known as a pea-separator, which will sort them out into the different and uniform sizes, and after having been carefully looked over for any yellow or black-eyed, which should be removed, they are scalded in wire baskets lowered into water which has been heated to a temperature of about 160° Fahr., until the skins begin to contract. The peas are then removed and filled into 2-lb. cans; the cans must not be quite filled, as the peas will swell in the processing; fill them only to within half an inch of the top of the can, and add brine to completely fill the can, made same as described for tomatoes. Cap and exhaust fifteen minutes at 212° Fahr., and process twenty minutes at 240° Fahr.

The dangers which may result from canning meats and meat products have been investigated by the English Local Government Board, and part of the Report which has been issued is given here.

ON THE PRESENCE OF TIN IN CERTAIN CANNED FOODS *

The Local Government Board's attention was prominently directed to the question of the metallic contamination of canned foods in 1906, when large quantities of such foods, sent to South Africa several years before, were disposed of in bulk, after the conclusion of the war, to speculative dealers at cheap rates, and were then imported, or re-imported, into this country. Active measures were taken in order that these goods might be examined, as far as was practicable at that time, by medical officers of health at the ports of arrival and at other places where they were ascertained to be deposited or put up for auction. In this way it was learnt that a considerable proportion of these foods had become unsound, in consequence of the development of gas in the interior of the cans, or of the contents having become so unsightly that no one would willingly use them for food, or for other reasons. In the case of certain beef essences already reported on, objectionable quantities of tin from the can were found to have been dissolved by the essence, with the result that the essence had become turbid and unfit for use.

The question of contamination by tin arose in other instances. With the assistance of several medical officers of health who had been actively concerned in the matter, I was able to secure a collection of different varieties of these foods. It seemed desirable to ascertain the condition of representative samples from this collection in respect of contamination by tin and generally to utilise the opportunity to review the question of tin in canned foods.

This was done by Dr. S. B. Schryver, D.Sc., who reports in detail below on investigations which he has made, in consultation with myself, on the subject. I would here draw attention to certain general considerations which arise from Dr. Schryver's report.

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* Local Government Board Report, No. 7. By Dr. Buchanan.

Contamination by Tin in relation to the Nature of the Canned Food. Practically all foods canned in the ordinary way become to some extent contaminated with tin as a result of the contact of the food with the tin-plate of the can. Tin is taken up by meat extracts and essences to a greater extent than by most other meat foods. This results from the acidity naturally possessed by the meat extractives in these preparations. Certain canned fruits and vegetables and foods such as canned soups of which the latter form part, are also specially liable to take up tin from the can in consequence of their natural acidity. Canned peaches, cherries, pears, apricots, pine-apples, tomatoes, asparagus, canned fruit puddings and tomato soup are included in this category. Notable quantities of tin have been found in certain samples of canned lobster.

In such cases tin may penetrate into the substance of solid foods, and in the case of canned foods which consist of both liquid and solid portions, *e.g.*, canned fruit, the solid portion may come to contain relatively larger proportions of tin than the liquid. This results from the fact that the tin, after solution in the liquid contents of the can, becomes in course of time adsorbed to, or chemically combined with, the solid contents.

Age of Canned Foods. As time goes on the quantity of tin taken up from the can increases, although there seems reason to believe that in the case of acid food-stuffs solution takes place at a somewhat greater rate during the first few months after canning than in subsequent periods. In course of Dr. Schryver's examination of the canned food from South Africa it was found that meat essences and extracts six years or more after canning contained usually from 1½ to 3 grains of tin to the pound, and that proportions such as 2 to 3 grains of tin per pound were met with in canned foods such as carrots, apricot jam, and fruit puddings which were of similar age. On the other hand, the degree of contamination in canned flesh foods of about the same age (brawn, curried rabbit, sausages, tongues, sliced bacon, &c.) was considerably less, usually ranging between ½ and 1½ grains of tin per pound of material.

Tin-plate. The quality of tin-plate used for the canning of foods varies very considerably, and there is no doubt that tin-plate is often employed in which the coating of tin has been reduced to a minimum from considerations of cheapness, with the result that a comparatively small erosion will in parts expose the steel or iron of the plate, and thereby facilitate an electrolytic action likely to accelerate the further solution of the tin.

Solder. If solder (containing both tin and lead) is allowed to gain access to the interior of the can, a very conspicuous solution of tin may take place. A can only a few months old in which this has happened may show a greater degree of tin contamination of its contents than a properly sealed can which has been kept for many years and used for similar material. In one instance in which Dr. Schryver found quite exceptional quantities of tin, 20 grains to the pound, pieces of solder were found in the contents of the can and no doubt were responsible for the exceptional figure obtained. Contamination by tin in this way is the more serious on account of the simultaneous risk of serious contamination by lead.

Significance of Tin in Canned Foods from the Standpoint of Public Health. In the case of arsenic it is well known that serious consequences are liable to follow from the continued ingestion in food or beverages of amounts of arsenic which in themselves are small and at first sight (particularly by comparison with ordinary doses given medicinally) might be thought of little or no account. Arsenic, when absorbed from the alimentary tract in these circumstances, is liable to be deposited in certain tissues, particularly the skin and peripheral nerves, and to produce neuritis and other symptoms of disease without previous manifestation of local irritant action. Somewhat similar considerations apply to lead. In the case of tin it has been established by the animal experiments of Ungar and Bodländer, cited by Dr. Schryver, that minute doses of tin salts, when introduced into the body by subcutaneous injection continued over a considerable period, produce a marked effect on general nutrition, and in particular affect the nervous system, causing paralysis and other symptoms. Dr. Schryver refers to a recorded case of chronic tin poisoning in man in which nervous symptoms similar to those in the experimentally produced chronic poisoning in animals occurred. In this case, however, the tin was not taken up through the alimentary tract, and Dr. Schryver has not succeeded in tracing instances in which similar effects have been reported as a result of the continued ingestion, along with food, of comparatively small doses of tin. Some experiments which he has made for the purpose of the report, in which he himself took daily doses of tin salts over a period of three weeks, suggest that in the case of food contaminated with tin the larger portion of the tin does not become absorbed from the gastro-intestinal tract, and that accumulation of tin in the body in these circumstances takes place at a comparatively slow rate. Dr. Schryver concludes that there is not much probability of serious risk of chronic poisoning by the absorption of relatively small quantities of tin as a result of a diet which consists largely of canned foods continued over considerable periods of time. This conclusion is in harmony with the fact that in the case of special communities (military and exploring expeditions for instance) where canned foods have formed a large part of the diet for a considerable period, no instances appear to have been reported in which deleterious effects have been attributed to metallic contamination of the food consumed. It must be remembered, however, that in the case of such communities it would usually be far from easy to refer obscure chronic ailments which might be associated with particular foods to their specific causes.

Some Dangers of Canned Food. Adopting provisionally the position that in the case of tin no sufficient cause has been shown for guarding against minute quantities of the metal in food-stuffs in the way that is needed in the case of arsenic and lead, it still remains necessary to consider the irritant action on the gastro-intestinal tract which may be produced by the presence of tin salts in considerable quantities in the food. It appears to be well established that such irritant action may take place, and that tin salts when present in foods in such quantities as might lead to one or two grains of tin being taken at a time, have produced severe illness in consequence of local irritation.

The concentration of the tin in the food, the condition of the stomach at the time the food was swallowed, the susceptibility of the individual, and other circumstances, would no doubt largely govern the result in individual cases, but these considerations are common to irritant poisoning generally, and do not call for comment here.

It is clear that canned foods which are capable of causing such symptoms contain much larger amounts of tin than occur in the canned foods ordinarily supplied for consumption. Dr. Schryver examined certain canned fruits between one and two years from the date of canning—an extreme limit for ordinary stock—selecting peaches, apricots, and other fruit specially liable to act on tin. In these samples the quantity of tin present did not in any case exceed one grain to the pound of fruit. There seems no reason to believe that such large quantities of tin as two or three grains in the pound would in ordinary circumstances be present in any of the usual canned foods of commerce, provided that proper care had been taken to avoid contamination of the contents by solder.

It would be unsafe to dogmatise as to the exact degree of contamination by tin which would render canned foods liable to cause irritation and so call for their condemnation, especially as much more of some canned foods is eaten at a time than others. Nevertheless it seems clear that in any kind of canned foods quantities of tin approximating to two grains to the pound are not only unusual and unnecessary, but also must be regarded with grave suspicion in consequence of the risk of irritant action of the tin they contain. It should be observed in this connection that the recorded cases, naturally enough, have been those in which very pronounced symptoms of irritation have occurred, and it is probable that smaller quantities than those concerned in these reported cases are capable of producing minor digestive disturbances, the cause of which could hardly ever be satisfactorily traced.

Canned Foods under Careful Scrutiny. In consequence of the Unsound Food Regulations recently made by the Board under the Public Health (Regulations as to Food) Act, 1907, canned foods will in future be subjected to greater scrutiny by the sanitary authorities at the places of importation than has hitherto been the case.

Some suggestions may be made in connection with this examination, and other occasions in which canned foods are examined by officers of sanitary authorities. Special attention should be directed, with the co-operation of the public analyst, to canned foods which there is reason to suspect to be of unusual age, *e.g.* more than one or two years, and, in particular, to such canned goods as those above referred to, in which the liability to act on tin is specially great. The presence in the contents of a sample can, of tin in quantities approaching two grains to the pound, may be taken to signify that the food has become potentially deleterious to health, and calls for further examination of other samples with a view to dealing with the consignment in accordance with the results obtained. Attention may here be directed to the description given by Dr. Schryver of the quantitative tests which he found to yield the most satisfactory results, and also to a new colorimetric method which he has found convenient in cases where it is desirable to examine a considerable number of samples together by a preliminary sorting test.* It may be observed in passing that the latter test may prove useful in cases where it is desired to ascertain whether "glass" packed foods are in reality canned foods which have been transferred to glass receptacles.

Canned foods are frequently condemned and destroyed by sanitary authorities in considerable quantities, on account of their having become blown, and for other reasons. Advantage may usefully be taken of such destruction to make systematic examination of large numbers of cans and ascertain the condition of the interior and contents of the can in regard to the access of solder. It should be remembered that the presence of a "solder-trap" at the place of puncture sometimes does not preclude access of solder through other punctures in the can.

Evidence of improper soldering obtained in this way will point to the desirability of special examination of future consignments of similar foods from the same canner or of the same brand.

Like observations apply to cans which on account of the inferior quality of the tin-plate show marked discoloration or erosion in their interior.

The inquiry illustrates the advantage which would be gained from the administrative point of view if the person or firm by whom canned foods are prepared were in a position to determine by marks, labels or otherwise the date and place of preparation, and could be required to furnish such particulars, on reason shown, to public health authorities concerned with food inspection and wholesomeness of foods. Such a practice would have advantages from other points of view, which need not here be gone into.

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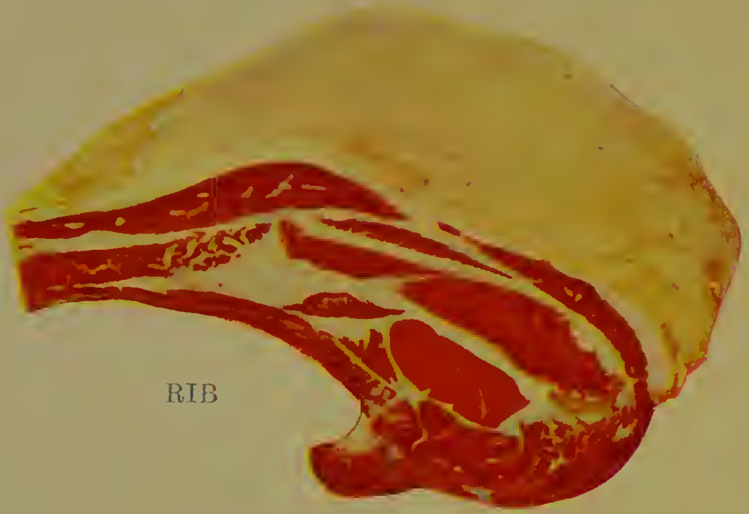
* *See* detailed report.

AMERICAN CUTS OF BEEF

Morris and Co., Chicago



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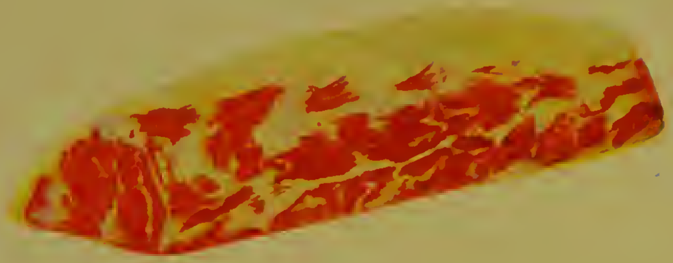

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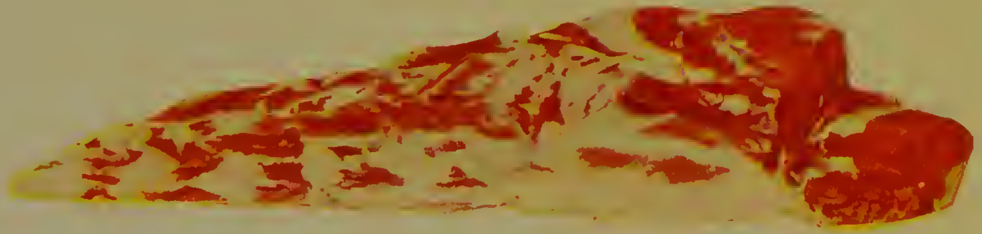

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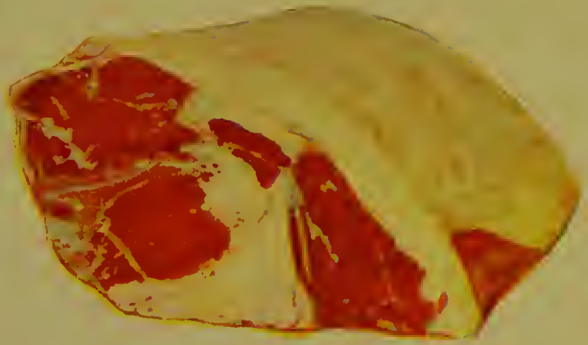

SHORT LOIN

26 JUL. 1929

CHAPTER XI

THE HANDLING OF MEATS

There are not any uniform methods of slaughtering live-stock and handling of meats.

Each country has its own peculiar ways, and in each, different methods are employed in different localities. In speaking, therefore, of the handling of meats, it must be borne in mind that while any description that might be given would apply to certain localities, it might not be quite accurate in matters of detail with regard to others.

It may be remarked in this place, however, that wherever animals are to be used for human food, it is a preliminary necessity that they should be in every case in a sound and healthy condition ; not only is this a necessity from an economic point of view, but it is also desirable from the point of view of public health.

At the same time it must be acknowledged that with regard to the number of diseases which are common in animals used for food, there is not much direct evidence in existence of the transmissibility of animal diseases to the human subject. That, however, is a question which is dealt with fully elsewhere in this work, and need only be incidentally referred to here.

In some countries the transport of the live animal is carried on with considerable difficulty. The illustration shows the loading up of cattle in Tangiers.

From the meat-purveyors' point of view it is necessary that all animals to be slaughtered should present the appearance of being well finished and without an excess of fat.

During recent years this fact has been illustrated at various live-stock shows throughout the United Kingdom, and notably at the Smithfield Club Show in London, where the meat-carcase classes have been instituted, and they have illustrated how utterly wide of the mark the breeding points are, as compared with what the meat-purveyors require.

What the meat-purveyors need is an animal with the maximum amount of flesh and the minimum amount of bone, and in connection with these carcase competitions, it is only fair to say that, during the last fifteen years they have so illustrated this particular point, that they have been instrumental in abolishing from the live-stock shows the huge mountains of fat which used to be exhibited, and whose prime quality in the eye of the breeder was their abnormal size. Overfed animals are of little use to the meat-purveyor, as the block test has demonstrated over and over again.

Transition in Meat Production. It is of interest to refer here to this transition in meat production which has taken place, because it was brought about originally by meat-purveyors, more especially in London, who kept on protesting that the Smithfield Club Show, held in December every year, was principally an exhibition of overfed animals, in which a large proportion of the bulk in the shape of fat, was mere waste.

In 1895, as a consequence of these protests, block tests were instituted, and have had the desired effect in bringing the breeders' points into line with those considered necessary by the meat-purveyors.

The order of procedure at such shows as that held by the Smithfield Club in connection with the carcase classes is, that the animals entered are first of all judged alive, and they are then taken to the Islington abattoir and slaughtered, the carcases being returned to the show, where they are judged as meat.

Obviously, such a course of procedure has been of high educational value, and has illustrated the wide divergence which exists between the judgments given to the live animals, and those awarded to the dead meat.

No better example of this could be given than the records of the carcase classes in the Smithfield Club Show, held in the Agricultural Hall, London, in December 1909, and these records, which are given here, show clearly that in the cattle classes, the awards given by the judges to the live animals did not correspond with those given to the carcases at all. The same remark applies to the sheep classes, and it is only in the pig classes that uniformity is attained. Obviously, this matter wants adjustment, and while the work so far accomplished has been satisfactory, there is yet much to be done so as to synchronise the points of view of the breeder and meat-purveyor.

SMITHFIELD CLUB SHOW, 1909. SPECIAL SLAUGHTER CLASSES FOR CARCASE COMPETITION

CLASS 94. STEER NOT EXCEEDING 2 YEARS OLD. 1ST PRIZE, £15; 2ND PRIZE, £10; 3RD PRIZE, £5; 4TH PRIZE, £3

No.	Live weight.			Carcase weight.		Suet, Caul, Reed, Fat.	Fat, Gut-fat, Trimmings.	Tongue, Tail.	Head, Feet.	Heart, Liver, Lights.	Tripe, Feck, Reed.	Hide.	Intestines.	Placed by judges alive.	Carcase award.	No.
	Cwt.	Qr.	Lb.	Stones (8 lb.)	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.			
575	11	2	1	106	3	14	25	11	56	38	91	88	14	1st	2nd	575
576	11	3	2	107	5	18	39	10	51	35	104	75	20			576
577	7	2	7	65	4	6	11	8	42	30	68	66	12			577
578	13	1	11	120	2	27	46	12	58	37	123	91	22	2nd	1st & Champion	578
579	12	3	18	115	6	20	54	12	60	42	60	105	23		4th	579
580	11	1	4	104	6	14	24	10	53	36	100	79	15	H. C.		580
581	10	1	10	81	6	16	23	9	52	36	141	88	19			581
582	10	2	26	99	1	17	27	11	51	33	98	83	14	3rd	3rd	582
583	9	1	6	82	4	17	30	9	44	28	97	67	12	C.	R. & H. C.	583
584	9	2	21	84	4	16	22	9	50	38	96	72	15			584

CLASS 95. STEER ABOVE 2 AND NOT EXCEEDING 3 YEARS OLD. 1ST PRIZE, £15; 2ND PRIZE, £10; 3RD PRIZE, £5; 4TH PRIZE, £3; 5TH PRIZE, £1

No.	Cwt.	Qr.	Lb.	Stones (8 lb.)	Lb.	Suet, Caul, Reed, Fat.	Fat, Gut-fat, Trimmings.	Tongue, Tail.	Head, Feet.	Heart, Liver, Lights.	Tripe, Feck, Reed.	Hide.	Intestines.	Placed by judges alive.	Carcase award.	No.
585	12	1	6	114	1	20	39	11	50	37	92	86	20			585
586	14	3	20	135	3	25	55	14	65	39	126	120	20	H. C.		586
587	15	3	12	153	3	31	55	16	62	41	95	111	24			587
588	15	0	16	142	1	36	55	14	60	45	119	88	25			588
589	12	2	24	112	7	24	36	12	59	41	128	86	21	3rd	3rd	589
590	13	1	15	122	5	28	41	13	59	42	115	89	18		2nd	590
591	Absent															591
592	Absent															592
593	12	1	16	111	3	26	56	11	53	38	97	95	21			593
594	10	2	26	95	2	26	32	9	52	34	85	83	15	C.		594
595	14	3	4	141	6	32	33	14	60	38	105	110	18			595
596	14	0	20	126	7	18	33	13	64	44	158	99	21	2nd	R. & H. C.	596
597	11	3	2	108	0	16	40	12	31	32	87	107	18		1st & R. Champion	597
598	9	2	7	86	4	22	31	10	47	54	82	69	16	1st	4th	598
599	11	3	22	105	4	29	36	11	55	38	103	91	20			599

CLASS 96. HEIFER NOT EXCEEDING 3 YEARS OLD. 1ST PRIZE, £15; 2ND PRIZE, £10; 3RD PRIZE, £5; 4TH PRIZE, £3

No.	Cwt.	Qr.	Lb.	Stones (8 lb.)	Lb.	Suet, Caul, Reed, Fat.	Fat, Gut-fat, Trimmings.	Tongue, Tail.	Head, Feet.	Heart, Liver, Lights.	Tripe, Feck, Reed.	Hide.	Intestines.	Placed by judges alive.	Carcase award.	No.
600	12	1	20	115	6	29	50	12	45	38	103	77	22		4th	600
601	11	1	16	104	7	18	31	11	47	34	111	75	21	1st	2nd	601
602	8	1	18	76	4	14	22	8	39	26	73	66	12		3rd	602
603	10	3	3	98	0	22	35	10	44	32	98	67	17	2nd	1st	603

SMITHFIELD CLUB SHOW, 1909

CLASS 97. ONE PURE LONG-WOOLLED WETHER LAMB NOT EXCEEDING 12 MONTHS OLD. 1ST PRIZE, £5; 2ND PRIZE, £3; 3RD PRIZE, £2; 4TH PRIZE, £1

No.	Live weight.	Carcase weight.	Fat.	Pluck.	Skin.	Placed by judges alive	Carcase award.	No.
	Lb.	Lb.	Lb.	Lb.	Lb.			
604	126	78	8	5	17	2nd	4th	604
605	125	81	9	4	12	1st	3rd	605
606	167	103	9	5	24			606
607	179	107	12	5	24			607
608	90	55	6	6	13			608
609	102	64	9	4	14	3rd	1st & Champion	609
610	79	48	4	4	12			610
611	78	46	5	3	9			611
612	133	84	7	4	14			612
613	92	54	6	3	12		R. & H. C.	613
614	125	76	8	4	17		2nd	614

CLASS 98. ONE PURE LONG-WOOLLED WETHER SHEEP ABOVE 12 AND NOT EXCEEDING 24 MONTHS OLD. 1ST PRIZE, £5; 2ND PRIZE, £3; 3RD PRIZE, £2; 4TH PRIZE, £1

615	88	50	5	3	12			615
616	155	92	7	5	17		3rd	616
617	124	79	8	5	17	2nd	2nd	617
618	128	81	10	4	17	3rd	1st	618
619	128	81	10	4	15	1st		619
620	134	87	10	4	12			620
621	195	130	7	16	19		R. & H. C.	621
622	118	74	7	4	12		4th	622

CLASS 99. ONE PURE SHORT-WOOLLED WETHER LAMB NOT EXCEEDING 12 MONTHS OLD 1ST PRIZE, £5, 2ND PRIZE, £3; 3RD PRIZE, £2; 4TH PRIZE, £1; 5TH PRIZE, £1

623	95	56	6	5	14			623
624	132	80	6	4	17			624
625	95	58	6	4	15			625
626	153	96	12	5	16	3rd		626
627	173	114	11	5	15			627
628	143	88	9	6	18	2nd	1st & R. Cham.	628
629	127	76	8	5	19	C.		629
630	151	87	16	5	17			630
631	118	73	7	4	15	H. C.	R. & H. C.	631
632	144	93	6	4	17		4th	632
633	136	86	8	4	14			633
634	158	98	12	5	15			634
635	124	75	6	5	15			635
636	119	69	9	6	16			636
637	85	54	5	3	10			637
638	159	99	11	4	19			638
639	119	77	9	4	17			639
640	166	107	13	6	18	1st		640
641	131	85	6	4	10		2nd	641
642	136	81	8	5	21			642
643	withdrawn							643
644	160	99	11	5	16		3rd	644
645	100	63	8	4	12			645

Smithfield Club Show, 1909

Class 100. One pure Short-woolled Wether Sheep above 12 and not exceeding 24 months old

1st Prize, £5; 2nd Prize, £3; 3rd Prize, £2; 4th Prize, £1

No.	Live weight.	Carcase weight.	Fat.	Pluck.	Skin.	Placed by judges alive.	Carcase award.	No.
	Lb.	Lb.	Lb.	Lb.	Lb.			
646	122	76	9	5	14			646
647	186	119	11	6	17			647
648	203	132	17	6	16			648
649	154	97	10	5	14		3rd	649
650	169	117	11	4	16			650
651	168	109	12	7	17		R. & H. C.	651
652	217	139	20	5	15		1st	652
653	215	142	14	6	19			653
654	117	76	8	4	14		2nd	654
655	138	86	9	4	14		4th	655

Class 101. One Cross-bred Wether Lamb not exceeding 12 months old

1st Prize, £5; 2nd Prize, £3; 3rd Prize, £2; 4th Prize, £1

656	125	76	9	5	21	1st	2nd	656
657	138	85	7	4	20			657
658	130	78	7	4	21	2nd		658
659	150	94	12	5	18	C.	4th	659
660	133	81	7	4	19		3rd	660
661	107	64	9	5	15		R. & H. C.	661
662	106	64	6	4	16			662
663	112	68	7	5	12	3rd		663
664	136	85	7	4	16			664
665	110	68	10	4	16		1st	665
666	81	51	9	5	12			666
667	84	52	6	4	12			667
668	90	57	6	3	8			668
669	99	59	3	3	15			669

Class 102. One Cross-bred Wether Sheep above 12 and not exceeding 24 months old

1st Prize, £5; 2nd Prize, £3; 3rd Prize, £2; 4th Prize, £1

670	212	140	9	$5\frac{1}{2}$	$27\frac{1}{2}$			670
671	135	85	11	5	13		R. & H. C.	671
672	136	83	11	6	17			672
673	141	88	13	3	14	1st	1st	673
674	100	60	6	6	16	C.		674
675	158	100	10	4	17			675
676	134	90	13	5	15	2nd	3rd	676
677	119	73	9	5	16		2nd	677
678	161	100	9	5	18		4th	678
679	127	79	13	5	12	3rd		679
680	124	76	9	5	16			680

SMITHFIELD CLUB SHOW, 1909

No.	Live weight.	Carcase weight.	Pluck.	Placed by judges alive.	Carcase award.	No.
CLASS 103. ONE PIG NOT EXCEEDING 100 LB. LIVE WEIGHT. 1ST PRIZE, £5; 2ND PRIZE, £3; 3RD PRIZE, £2; 4TH PRIZE, £1						
	Lb.	Lb.	Lb.			
681	89	69	5			681
682	94	76	4			682
683	78	62	4			683
684	96	74	5	2nd	2nd	684
685	89	68	5	3rd	3rd	685
686	70	47	4			686
687	91	70	4			687
688	80	58	5			688
689	89	73	5	4th	4th	689
690	94	74	5	1st	1st	690
CLASS 104. ONE PIG, NOT EXCEEDING 9 MONTHS OLD, ABOVE 100 LB. AND NOT EXCEEDING 220 LB. LIVE WEIGHT 1ST PRIZE, £5; 2ND PRIZE, £3; 3RD PRIZE, £2; 4TH PRIZE, £1						
691	181	143	11			691
692	163	123	9		R.	692
693	194	157	9	3rd	3rd	693
694	145	115	8		4th	694
695	167	132	9			695
696	183	154	8			696
697	217	172	10	2nd	2nd & R. Champion.	697
698	204	171	8	1st	1st & Champion.	698
699	Absent					699
CLASS 105. ONE PIG, NOT EXCEEDING 12 MONTHS OLD ABOVE 220 LB. AND NOT EXCEEDING 300 LB. LIVE WEIGHT 1ST PRIZE, £5; 2ND PRIZE, £3; 3RD PRIZE, £2; 4TH PRIZE, £1						
700	252	215	11	4th	4th	700
701	271	226	13	2nd	1st	701
702	Absent					702
703	256	207	12	3rd	3rd	703
704	260	207	12		R.	704
705	305	256	13			705
706	286	244	11	1st	2nd	706

In connection with these competitions a serious question has arisen as to what points in the carcases should be given the awards of merit, and, as there is considerable divergence in opinions which exist, it seems desirable that a uniform scale of standards of excellence should be established, and that these standards should be universally adopted wherever carcase competitions are held.

The Tables which are given here have had the advantage of being scrutinised by experts in various parts of the United Kingdom, and have, in that way, attained an authority which it is desirable they should possess. It will be seen that the points vary in carcases of beef, mutton, pork and veal, and that due regard has been had to the main features of the carcases, in so far as the dressing, general appearance, and proportion of meat to bone are concerned. The general design of the other parts given, is based on the view that the highest points are awarded to the features which translate themselves into the greatest monetary return to the meat-purveyor.

STANDARD OF EXCELLENCE FOR JUDGING THE CARCASE OF A BULLOCK

(Leighton and Douglas)

(1) Workmanship and handling of carcase . . .	5
(2) Colour and general appearance of carcase . .	10
(3) Conformation of carcase and proportion of meat to bone	10
(4) Proportion of meat on hind-quarter and roasting parts	15
(5) Thickness of sirloin	20
(6) Conformation of fore-quarter, embracing fleshy spare-rib and shoulder, proportion of meat to bone. .	10
(7) Thickness and fleshiness of brisket or breast . .	5
(8) Smallness of neck	5
On quartering the carcase the following points to be noted :	
(9) Colour and texture of flesh	10
(10) Marbling of flesh	10
Total	100

Notes

(1) *Workmanship and handling of carcase.* The points given for these have regard to the butchering, splitting, flaying and cleanliness of carcase.

(2) *Colour and general appearance.* The yellow or pale appearance is objectionable. What the public require, is a carcase with creamy colour; anything else prejudices the sale.

(3) *Conformation.* The carcase should be plump and well formed. The essential feature is the proportion of meat to bone, as it is upon this characteristic that the value is arrived at by the meat-purveyor.

(4) *Hind-quarter and roasting parts* get extra points because they carry a very large proportion of the valuable flesh.

(5) *Sirloin.* The sirloin gets the highest points because it carries the most esteemed flesh on the carcase.

(6) *The fore-quarter.* The fore-quarter does not realise so much as the hind-quarter, owing to its being largely used for boiling, stewing and pickling.

(7) *The brisket.* The brisket is mostly used for boiling and pickling, and for such purposes is most valuable when carrying a large proportion of meat to bone. Generally the brisket of a bull carries more flesh than that of a bullock, and a cow carries least of all.

(8) *The neck.* A small neck is generally associated with a large proportion of flesh to bone.

(9) *Colour and texture.* A healthy ruddy colour is essential to all good meat. The texture of meat when in perfect condition gives a fine soft touch and the fibre of the meat is free from coarseness.

(10) *Marbling.* The marbling of the flesh arises to a large extent from the feeding and the breeding of the animal, but is influenced by age. The carcase of a young animal (say, 20 months old) when well finished, will generally present a beautifully marbled appearance.

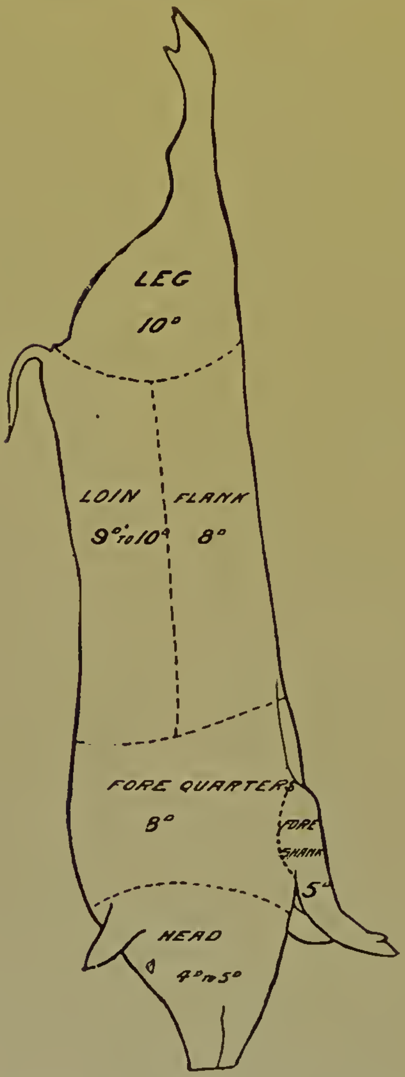

Diagram of a Side of Pork
Showing average prices for various cuts realised throughout the United Kingdom.
(Copyright of Loudon M. Douglas.)

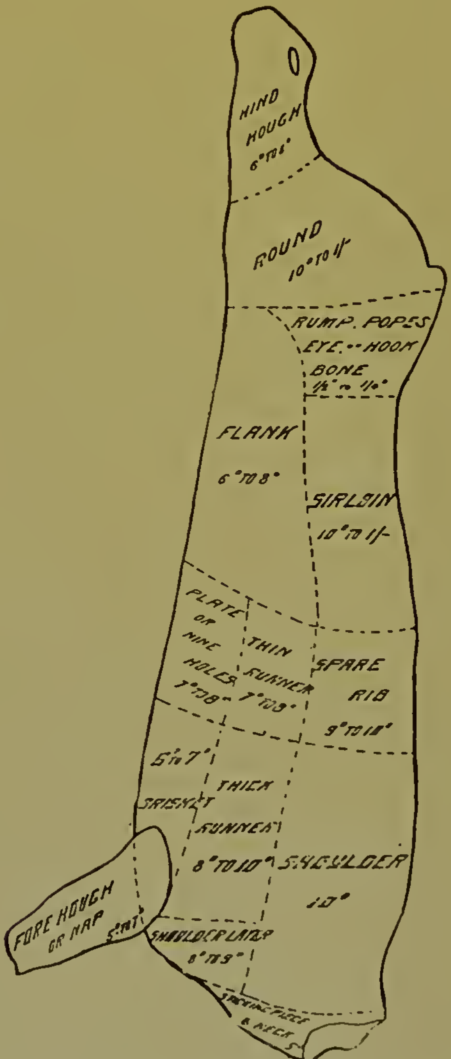

Diagram of a Side of Beef
Showing average prices realised throughout the United Kingdom for various cuts.
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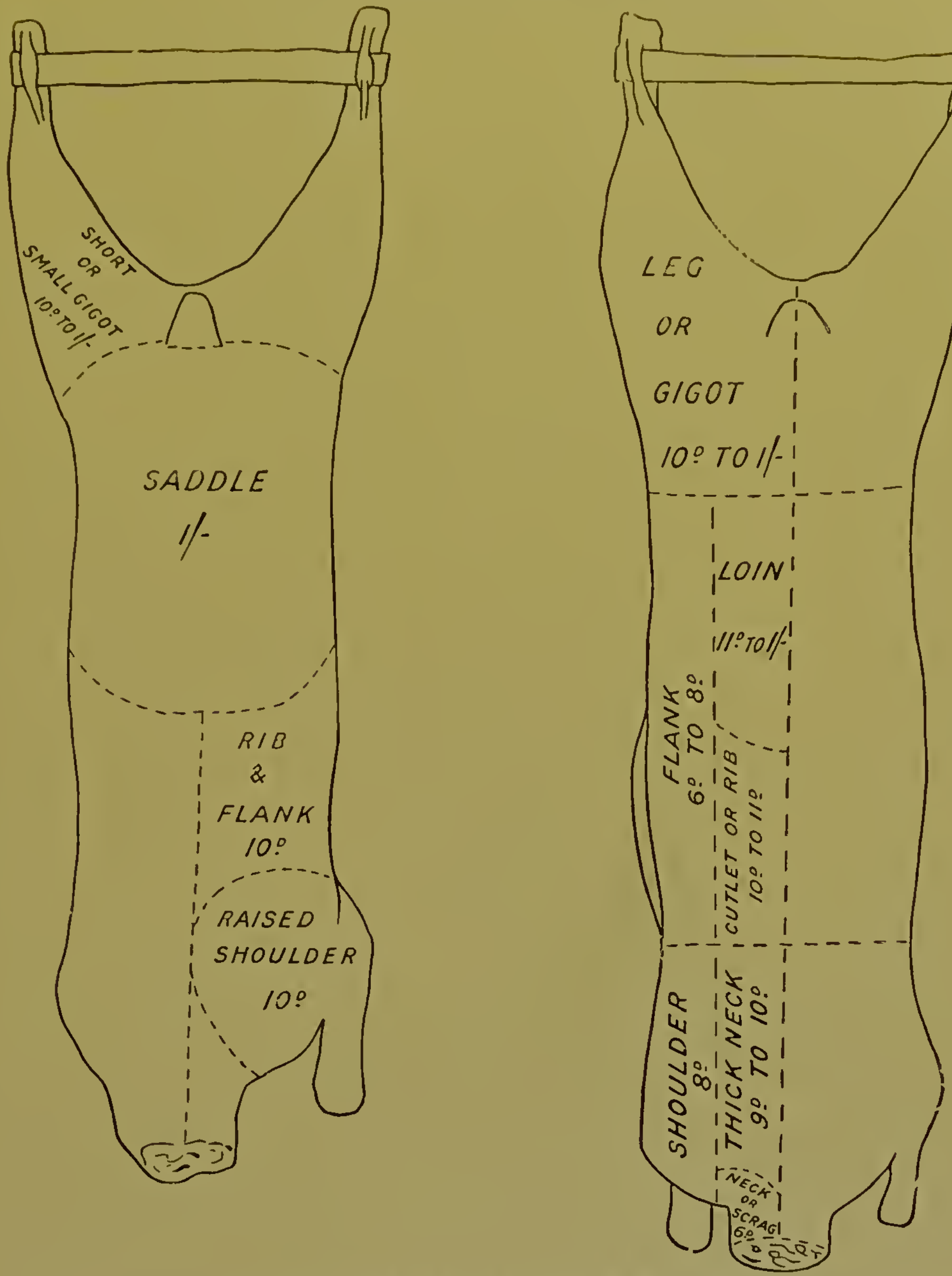


Diagrams of Carcases of Mutton

Illustrating the various cuts and different methods of cutting up, as also the average prices in the United Kingdom. (Copyright of Loudon M. Douglas.)

STANDARD OF EXCELLENCE FOR JUDGING A CARCASE OF VEAL

(Leighton and Douglas)

(1) Dressing of carcase	10
(2) General appearance, paleness and firmness of flesh	15
(3) Proportion of meat to bone	15

On splitting the carcase into halves the following points are to be noted :

(4) Plumpness of " fillets " or legs	25
(5) Thickness of loin and texture of flesh	20

(6) Thickness of fore-quarter, including the "oyster" or shoulder of veal and thickness of breast	10
(7) Smallness of neck	5
Total	100

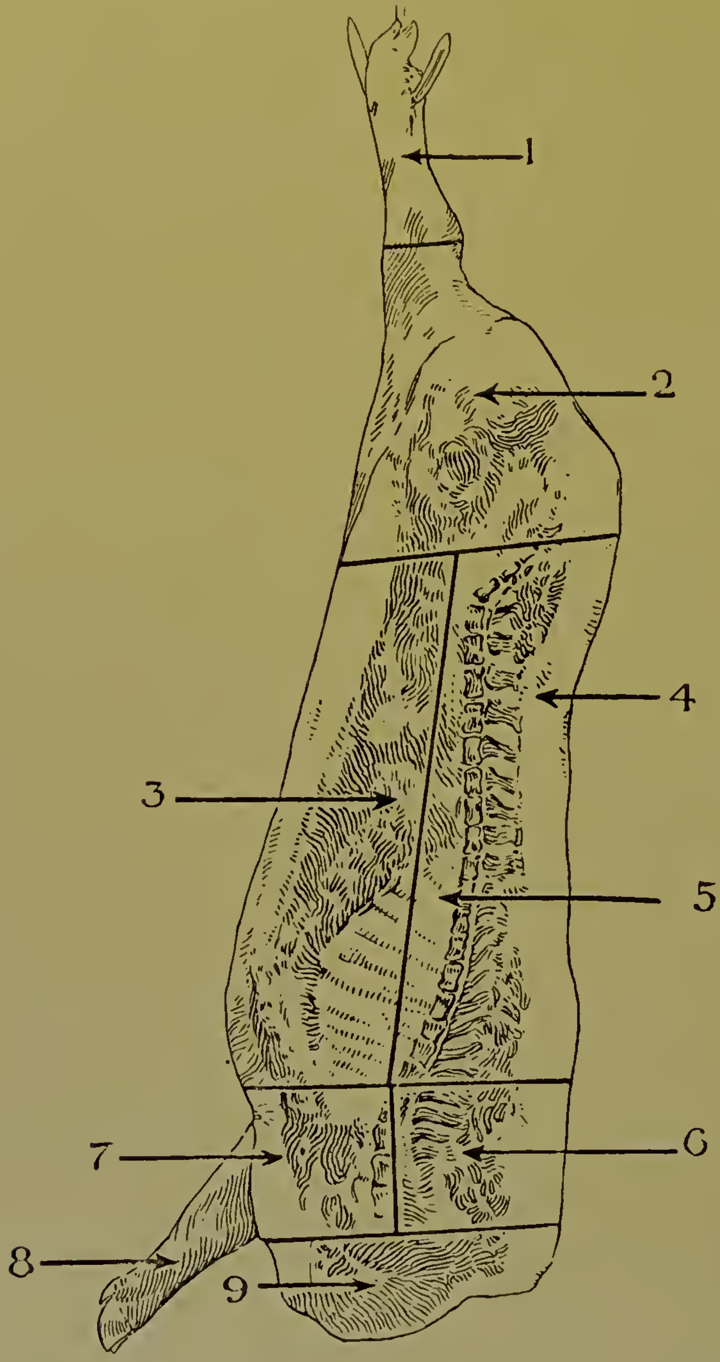


Diagram showing the principal Cuts of a Side of Pork, as practised in the United States.

(1) Hind foot.
(2) Ham.
(3) Rib belly.
(4) Fat back.
(5) Pork loin.
(6) Cala ham butt.
(7) Picnic or California ham.
(8) Fore-foot.
(9) Neck.

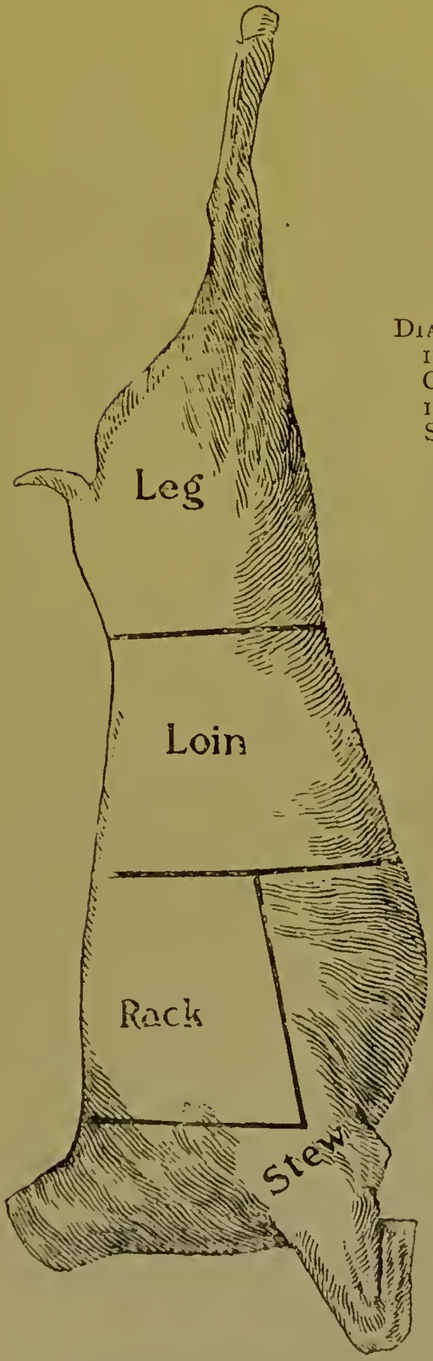
STANDARD OF EXCELLENCE FOR JUDGING A CARCASE OF PORK

(Leighton and Douglas)

(1) Dressing of carcase	5
(2) General appearance and firmness of flesh and fat	10
(3) Proportion of meat to bone	15

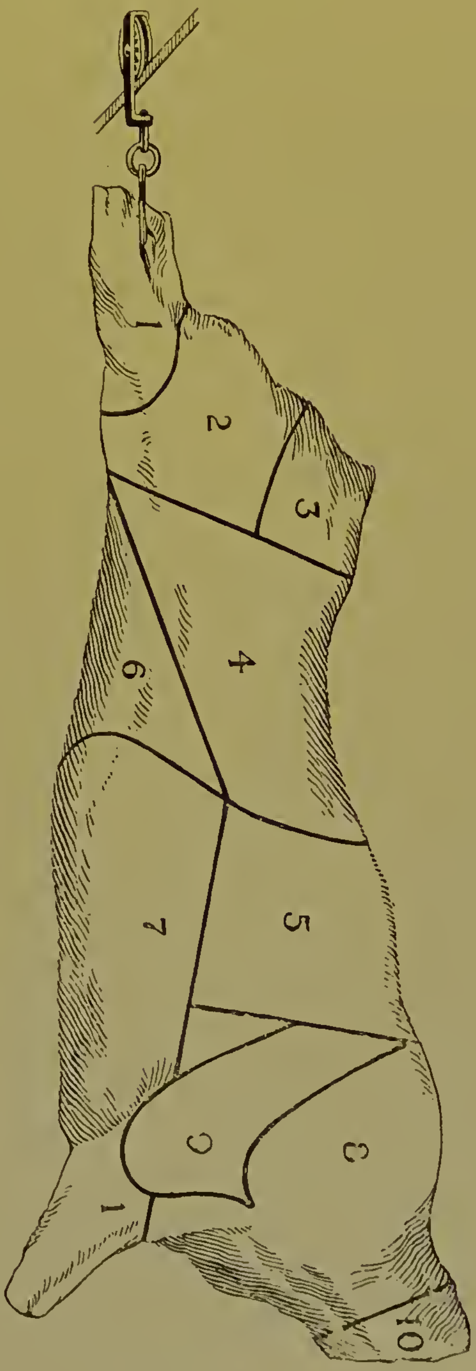
On splitting the carcase into halves the following points are to be noted :

(4) Plumpness of legs	20
(5) Thickness of loin and smallness of proportion of fat to lean	20
(6) Streakiness of belly part	10
(7) Fleshiness of fore-quarter	15
(8) Smallness of head	5
Total	100



Diagrams showing principal Cuts of Beef in the United States.

(1) Shank.
(2) Round.
(3) Rump.
(4) Loin.
(5) Rib.
(6) Flank.
(7) Plate.
(8) Chuck.
(9) Clod.
(10) Neck.



STANDARD OF EXCELLENCE FOR JUDGING CARCASES OF MUTTON AND LAMBS

(Leighton and Douglas)

(1) Dressing of carcase	10
(2) Colour, general appearance of carcases and firmness of fat	10
(3) Proportion of meat to bone	15

On splitting the carcase and dividing it transversely the following points are to be noted :

(4) Colour, texture and thickness	10
(5) Plumpness of legs of mutton	20
(6) "Eye" of the chops and thickness of loin	25
(7) Fleshiness of fore-quarters	10
Total	100

Age for Slaughtering. The ages at which various animals should be slaughtered for food vary somewhat, and indeed it would not be possible to dogmatise on the question. It is obvious, however, that meat from aged animals is likely to be tougher than that derived from younger ones. On the other hand, very young animals are not slaughtered for food, owing to lack of flavour and the high watery contents of the meat.

Cattle may be used for beef in 15 to 20 months, but ripeness may not be fully attained for 30 months. Veal should never be taken from animals less than 10 weeks old ; pigs under 6 weeks old should not be utilised, but are well within the requirements of the meat-purveyor from 5 to 12 months old. Sheep, on the other hand, may be utilised when from 2 to 3 months old and onwards, up to 2 years, but mutton which is 12 months old is generally regarded as being in a ripe condition.

Care of Animals for Slaughtering. It is essential that animals which have to be slaughtered for food should be first of all fasted for at least twelve hours, and for this purpose fasting-pens are usually provided in both public and private abattoirs. The object of the fasting process is to prevent the system being gorged, and the blood being filled with an excess of nutritive matter, which is driven to the extremities of the capillary blood-vessels, in which condition it is difficult to eliminate the whole of it from the flesh. The excess of blood in the meat, which results from the cause indicated, renders it very unattractive to the eye. It also militates against its keeping qualities, as decomposition, in the presence of an excess of blood, is very rapid.

While food should not be given to animals intended for slaughtering, water should be supplied in abundance, so that the temperature of the body may be maintained in a normal condition, and waste matter be cleansed out of the system.

Tools required in Slaughtering. There is a great variety of implements in use in connection with the slaughtering process, but those which are essential consist of pole-axe, saw, steel, sticking-knife, flaying-knife, gambrel or spreader, pritch and hog-scraper. Other appliances beyond these are frequently brought into use in different localities, and these are all set forth and described in the various illustrations accompanying.

Slaughtering of Animals : The Bullock. The animal is first of all drawn, by means of a rope passed through a ring in the floor, to the slaughtering site, which may either be a slaughtering booth, or the floor of a large slaughtering hall in an abattoir. The ring may be fastened in the wall instead of in the floor, but in any case the object in view is the same, *i.e.*, that the head of the bullock may be drawn to a certain fixed position and held there.

By means of a pole-axe, pistol or humane slaughtering apparatus, a perforation is made in the middle of the roof of the cranium, and this causes instantaneous unconsciousness, owing to the concussion which immediately supervenes.

The pole-axe is the weapon which is very largely used, and it is customary to deliver the blow on the middle of the forehead of the animal with the small end of the pole-axe, in this way perforating the skull. As soon as this has been done a wand is inserted through the perforation, so as to destroy the brain matter and *medulla oblongata.* The various methods of reducing the animal to this preliminary unconsciousness are discussed in detail (*see* Vol. III., Chap. I.), and these various methods have their advocates. When the animal falls, unconsciousness takes place, and the bleeding is then proceeded with as soon as possible.

According to the Jewish methods, stunning is not resorted to at all previous to the bleeding, but the animals are thrown by means of a mechanical device, and the throat is cut with an extremely sharp knife down to the vertebral column.

The ordinary method of bleeding, however, in the case where animals are previously stunned, is thoracic. The gullet is first of all opened and the main vessels of the neck (carotid and jugular) are severed.

When the blood has flowed out, the animal is turned on its back, and is supported in this position either with blocks of wood or pritches. The feet are then cut off and the head severed ; an incision is made in the hide, right down the forearms to the crown of the chest, and this line is continued along the middle line, from the chest to the base of the tail. Diagonal lines are then made down the hind legs, and flaying is started. The hide is first of all removed from the breast on the left side, and then on the right, and in order to facilitate operations later on the breast is then sawn through and the "gips" "izening" bone, or pelvis, is also severed.

A gambrel is then inserted under the sinews of the hind houghs, and the carcase is raised by means of a crane or self-sustaining hoist, and is suspended in the half-raised position, so as to allow of the hind-quarters being "buffed" or flayed. The hide is then pulled down, and the tail is liberated. At this point the whole carcase is raised up, so that only the shoulders rest on the floor, and an incision is made near the centre middle line, and the thick fat or "crook" lining the abdomen is at once taken out. The paunch or stomach is then withdrawn, and the intestines, including the liver are removed. The bed fat, however, lining the pelvis, and also the kidney fat, should be left undisturbed.

The intestines, being attached to the liver, can be cut free, and as the paunch is attached to the back, at the left side, it can be removed by merely pressing it downwards. The paunch, together with other intestinal offal, is thrown aside, so that it may be dealt with by others than those who handle the carcase.

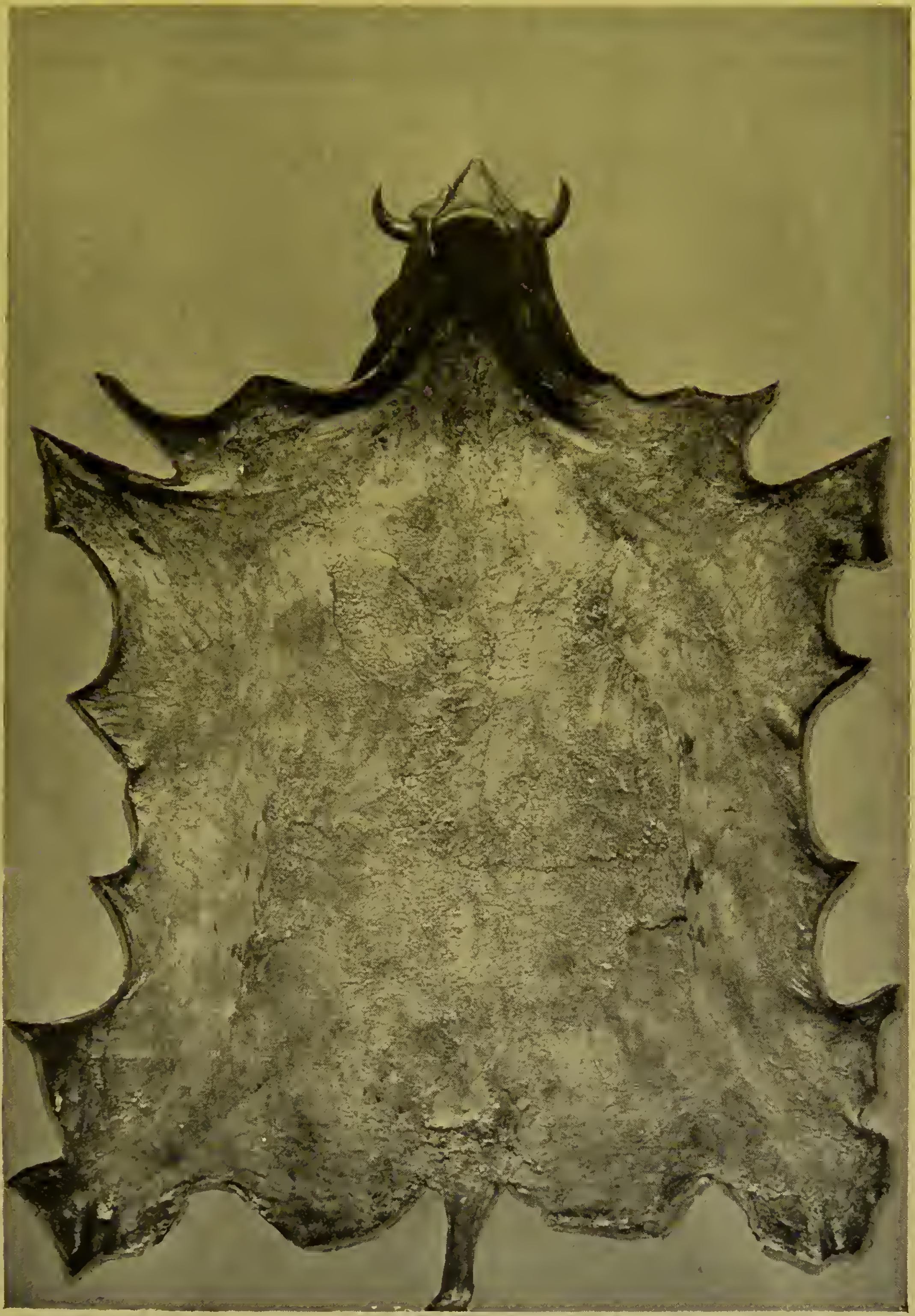
The gall-bladder is then taken out, and the diaphragm, lungs, and heart are removed, after which the carcase is raised to the vertical position, and, in accordance with local custom, split down the backbone or vertebral column. In Scotland, it is customary to split the carcase of a bullock from the front by means of a cleaver. In other parts of the country, however, this same process is carried out from the back, and in some cases the splitting is performed with a heavy cleaver or a saw. In the city of Edinburgh, which may be taken as a typical example of what occurs in Scotland, the carcase is kept entire, after being split down the backbone: that is to say, that the two sides are not severed entirely, but are kept united by means of a portion of skin.

When the carcase has been elevated to the vertical position, the hide, which at that moment should cover the shoulders only, is finally removed from the fore-quarters. The kidney fat should then be turned over, and the kidneys removed, the turning over of the fat being meant to give a good dressed appearance. When these operations have been completed, the whole carcase is washed out with warm water, and is wiped free from any blood or other matter which may be adhering to it.

The carcase is then in a finished state, and is at once placed in a position where it will cool, or where the animal heat may be allowed to dissipate. This may either be the hanging hall of an abattoir, or in the open space of a private slaughtering booth, but in any case, this pre-cooling should only be allowed to continue until the excess of animal heat has disappeared.

The carcase may then be placed in a chill room, where available, and chilled to a temperature of 40° Fahr., when, after about twelve hours, it will be in a firm condition, and be capable of being handled for all purposes in connection with the meat trade.

VEAL. The dressing of veal follows pretty much the same lines as that of beef. It is customary in some places, not to previously stun the animal, but to raise it by the hind feet and sever the neck arteries while in a vertical position. This custom, however, is gradually dying out, and it is being recognised that it is not only more humane, but quite as satisfactory, to stun the animal first. It is usual also to leave the hide of the veal on the carcase until the actual cutting-up begins, thus, the hide will not be removed until the veal has really set, and it is considered that, by this means, the flesh presents a pale and better appearance. The hide is sometimes removed partially from



Perfectly Flayed Bullock's Hide

the shoulders and hind legs, and, while the carcase is warm, the loose fat surrounding the paunch is taken out, and laid over these portions.

What is required in the appearance of veal is, that it should be pale and clean-looking.

The fat should be plentiful, and be very white and short in texture.

Sheep. Sheep should be dressed very rapidly, owing to the fact that mutton is very liable to have the "sheepy" flavour imparted to it, through the generation of gases arising in the stomach immediately after the animal has been killed. The usual method is to tie up three legs of the animal, leaving one free, and the animal is then placed on a bench or rack, in such a position that the head projects over the side. It is not usual to stun sheep in the United Kingdom, but it is quite common in some continental countries, and whether stunned or not, the subsequent operations are identical.

Finished Pigs in Chicago Stockyards

While the animal is in the position indicated, a knife is inserted through the neck just behind the jaw; the cutting edge of the knife should be in the direction of the spinal column, and the intervening tissue is severed, as well as the spinal cord, so that unconsciousness is instantaneous. The carcase is allowed to bleed, and the trotters or feet are cut off immediately. The skin is then removed by making an incision down the forearms, and continuing it along the middle line of the breast to the base of the tail. Incisions are also made diagonally up the hind legs, and flaying is then proceeded with.

The skin is first of all removed at the breast, and then along either side until it is completely off, leaving it attached to the tail. A gambrel is then inserted under the sinews of the hind legs, and the carcase is raised to what is known as the "horning heck," which is only another name for hanging hook.

When in this position an incision is made on the middle line, and the carcase is then opened. The intestines are removed by cutting around

American Sheep in Chicago Stockyards

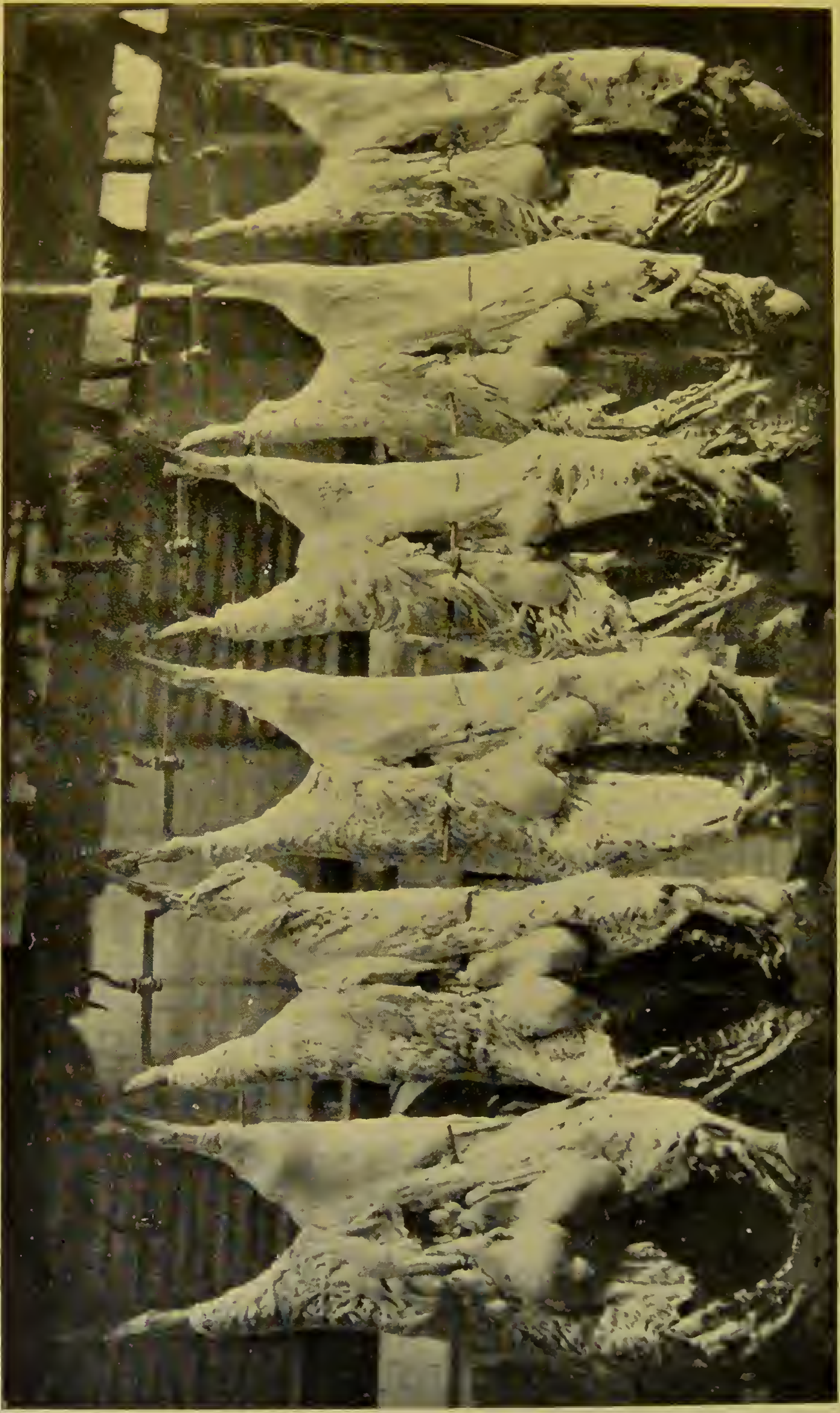
the rectum, so that the intestines drop inside and may then be easily taken away. The pelvis, in the case of the dressing of sheep, should not be split, except in warm weather so as to allow of rapid cooling, but the breast-bone is cut through, after which the paunch and intestines are removed, the liver being left attached to the diaphragm. The heart, lungs and diaphragm are taken out and the carcase is cleansed, and wiped free from blood or other matter which may be present. The carcases are then hung with the foreshanks resting against the wall or a partition, so as to press the shoulders back. A wooden spreader or "set" is then inserted so as to open the body and allow it to cool rapidly, and in this way the operation of dressing is complete.

Generally speaking, sheep slaughtering in the large way involves the employment of the following hands:

(1) Tier, to tie the three legs together, and lift the animal on the slaughtering stool. He sometimes slaughters the animals as well.

(2) Lad, to remove feet and assist in opening the skin.

Typical Herd of Bullocks in the Chicago Stockyards



Typical Carcases of Black-faced Lambs fed in Yorkshire

(3) Lad or man, to remove the animal to a second stool for the final flaying.

(4) Man, to raise carcase to the hanging "heck," and finally remove skin, open carcase, remove all intestines, and split the breast part. This latter operation, however, may be done either when the carcase is lying on the stool, or when it is hanging in the vertical position.

The cooling of sheep should be conducted in a fresh airy place, and the animal heat should be allowed to dissipate before any attempt is made to chill the carcase, provided the appliances are at hand for so doing.

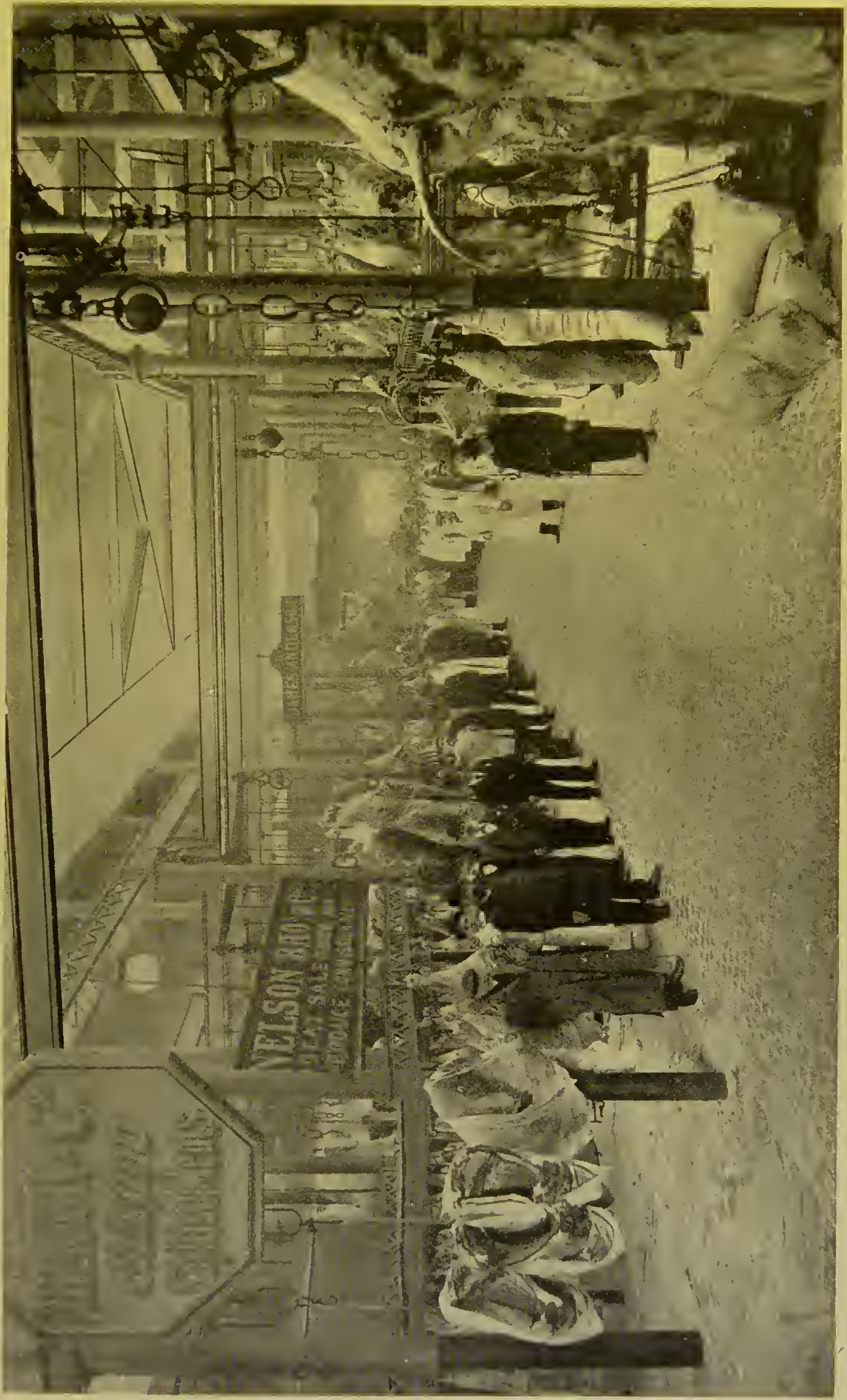
Another Illustration showing Typical Carcases of Black-faced Lambs fed in Yorkshire

Dressing of Pigs. The dressing of pigs for ordinary shop purposes follows much the same lines as those adopted in a bacon factory. Stunning is not uncommon when the pigs are to be used for fresh pork, and this is done either by means of a broad-faced mallet, or by a small pole-axe, and has the advantage of reducing the animal to instantaneous insensibility.

The carcase is slung into a vertical position, and a knife is inserted diagonally in the direction of the heart, but care must be taken to avoid sticking it into either of the shoulders, otherwise these parts of the carcase would be injured. The arteries to be severed are those which lie close together just inside of the breast bone, and the skilful operator will sever them at once.

The carcase is then thrown on to the dumping-table, and the leg chain removed, after which it is rolled into the scalding tank, of dimensions suitable to the operations to be carried on, the water in the tank to be of sufficient depth to allow of the carcase being entirely submerged, and the temperature should be about 180° Fahr. for fully developed animals,

Slaughtering and Skinning Pigs in the Glasgow Abattoirs



THE MEAT MARKET AT THE GLASGOW ABATTOIRS and about 20° less for young animals. The object of the scalding tank is to enable the hair to be easily scraped off, and it will be necessary to judge when this is done by pulling some hair away during the scalding process.

Care must be taken not to have the water too hot, as in that case the hair is likely to adhere more tightly to the skin, owing to expansion. The carcase will also get too red an appearance.

When the hair comes off easily in the hand the carcase should be removed from the scalding-tank, and thrown on to the scuttling table, where it is scraped free from hair. A gambrel is then inserted under the sinews of the hind feet, and the carcase is suspended on a track-bar, and while in this position the intestinal offal is removed. The carcase is opened right down the middle line from the base of the tail to the throat, care being taken not to allow the knife to penetrate so far that it will injure the intestines, and this is avoided by guiding the point of the knife with the fingers of the left hand. The breast-bone is split, either with a knife or with a cleaver, and is cut right down to the sticking-place. An incision is then made around the rectum, and the intestines pulled down until the kidneys are reached. The attachments being severed with a knife, the kidneys and kidney fat are allowed to remain, and the intestines and stomach are removed, and the gall bladder, which is attached to the liver, is taken out.

The diaphragm is cut right round, and the "pluck," consisting of the liver, heart and lungs, is removed. The carcase is then washed out with cold water, and wiped with a cloth as in bacon curing. Sometimes it is desirable to remove the backbone, and this facilitates the cooling of the carcase, but for shop purposes the backbones are generally left intact. The animal heat in pork takes about five to six hours to dissipate, and if chilling is resorted to, it should be seen that it is always accomplished by a circulation of air in the chill-room, otherwise there is a tendency for slime to appear on the skin.

By-products. By-products from cattle, sheep and pigs are treated of at length under the chapter entitled "By-products" in an earlier part of this volume.

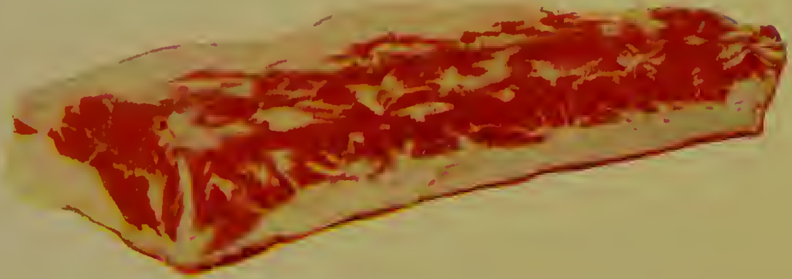
Diagrams. A series of diagrams illustrating the cutting-up of carcases of beef, veal, mutton, and pork are inserted on pages 697 to 704.

These diagrams fully explain themselves, and it is only necessary to say that they have been drawn out to illustrate the various methods in use for the handling of dressed carcases in shops.

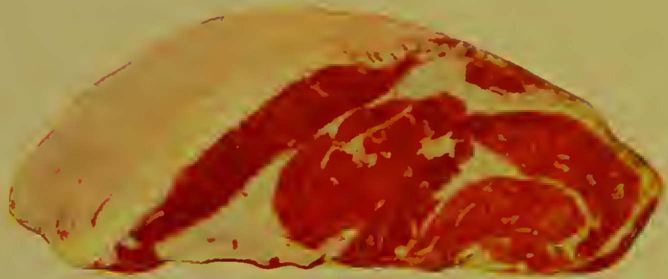
PLATE XIV

AMERICAN CUTS OF BEEF

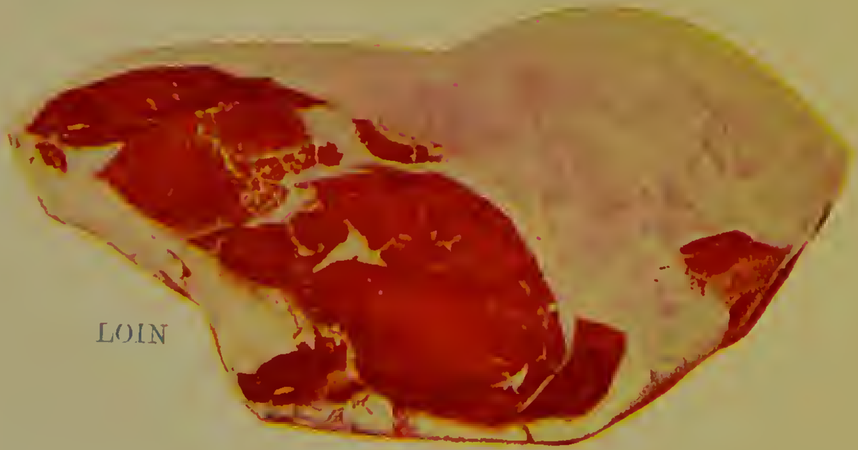
Morris and Co., Chicago



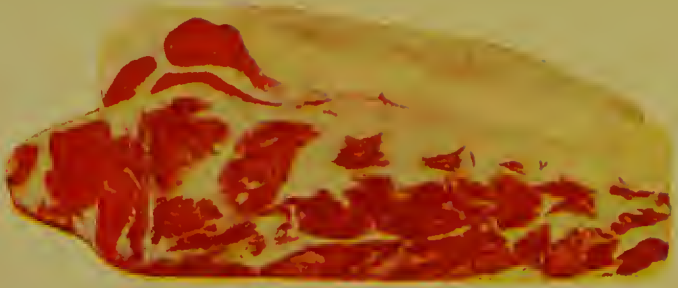
BONELESS STRIP LOIN



SIRLOIN BUTT



LOIN



SPENCER ROLL

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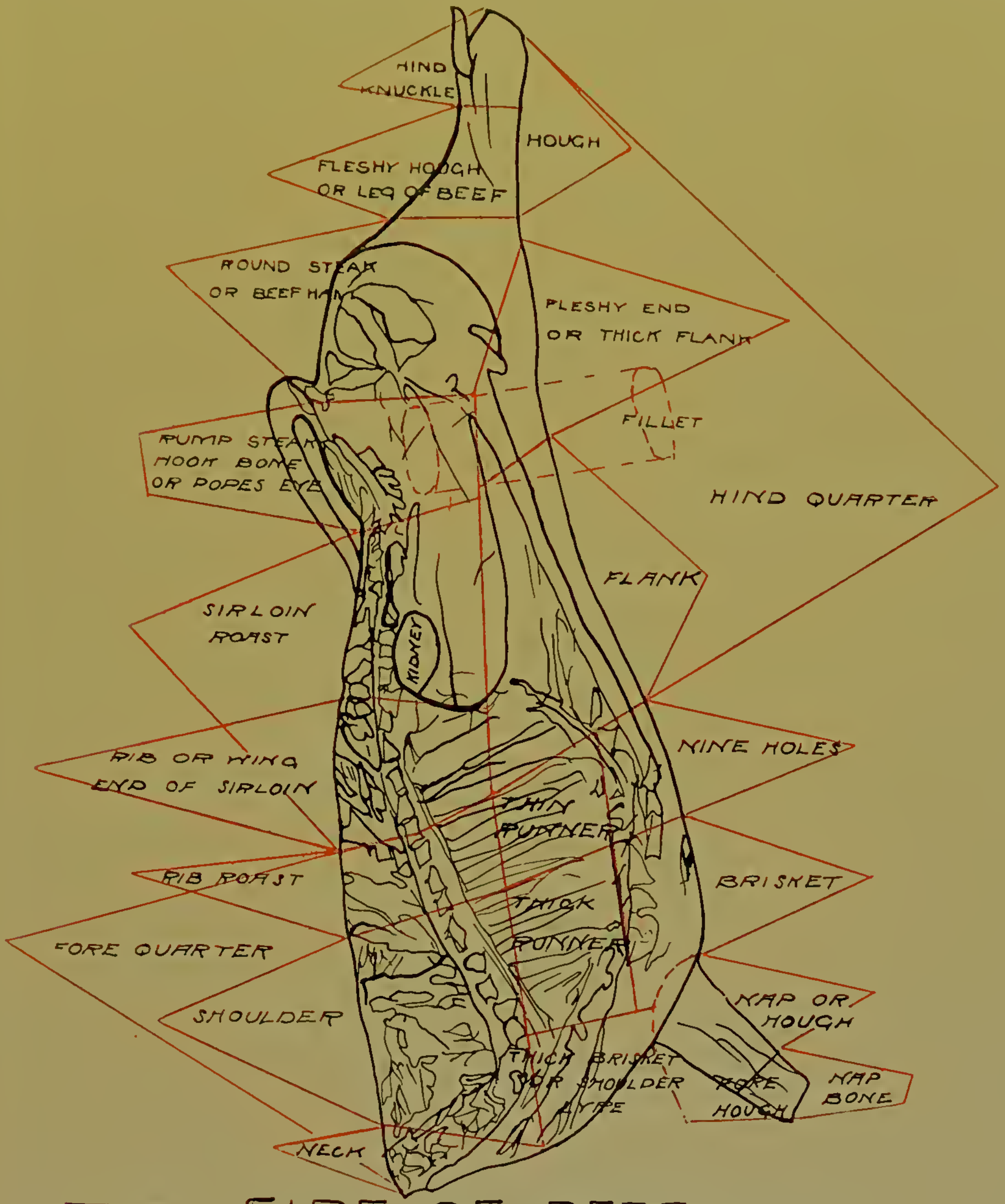
THE HANDLING AND CUTTING OF MEATS

THE SYSTEMS IN LONDON AND SCOTLAND ILLUSTRATED



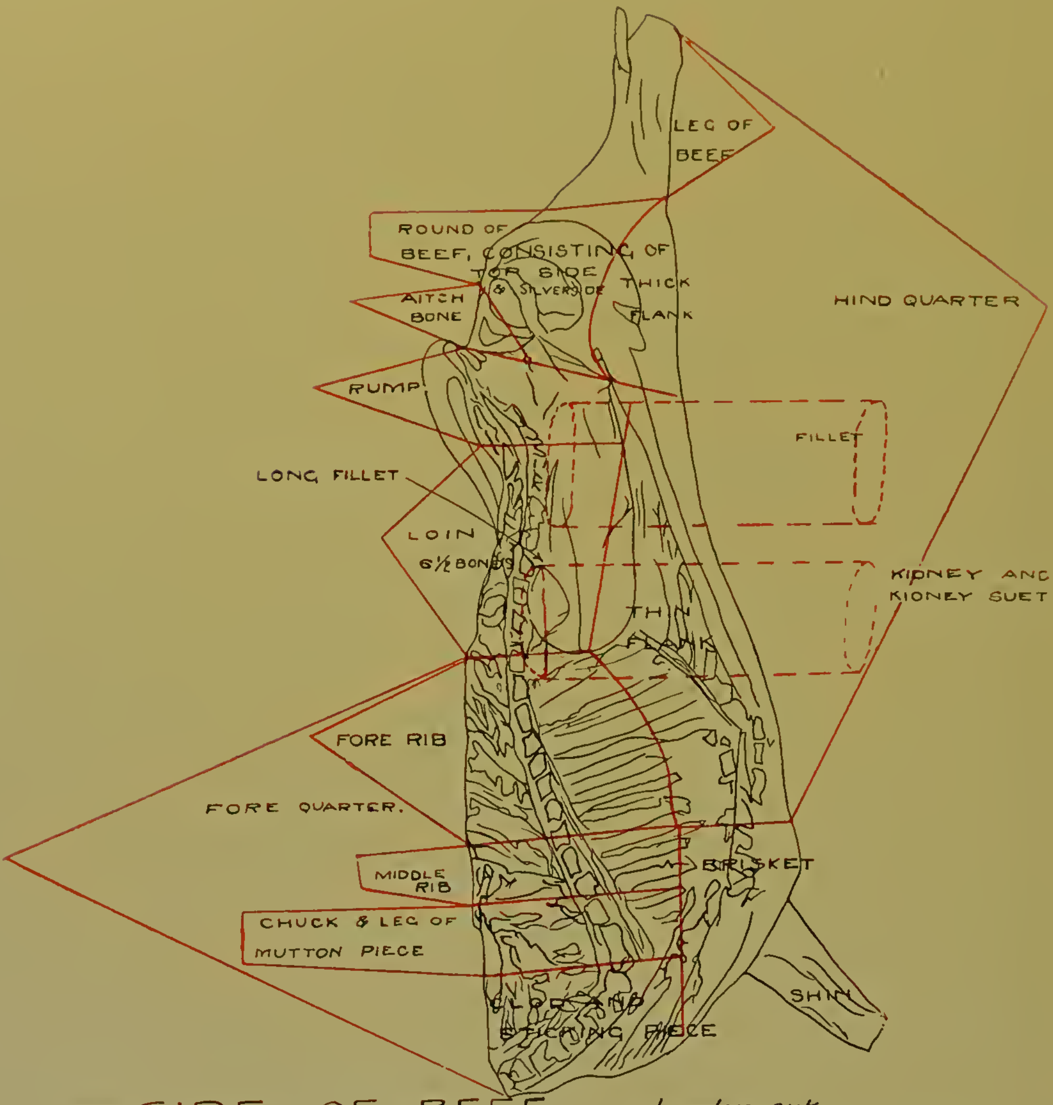
SIDE OF BEEF

Scottish cuts

Showing the parts into which it is cut by meat-purveyors in Scotland

Trade terms

Hind knuckle
Hough
Fleshy hough or leg of beef
Round steak or beef ham
Fleshy end or thick flank
Hind
Fillet
Rump steak, hook-bone, or pope's eye
Flank
Sirloin (roast)
Quarter
Kidney
Nine holes
Thin runner
Rib (roast)
Brisket
Thick runner
Shoulder
Fore-quarter
Nap or hough
Thick brisket or shoulder yre
Nap-bone
Fore hough
Neck



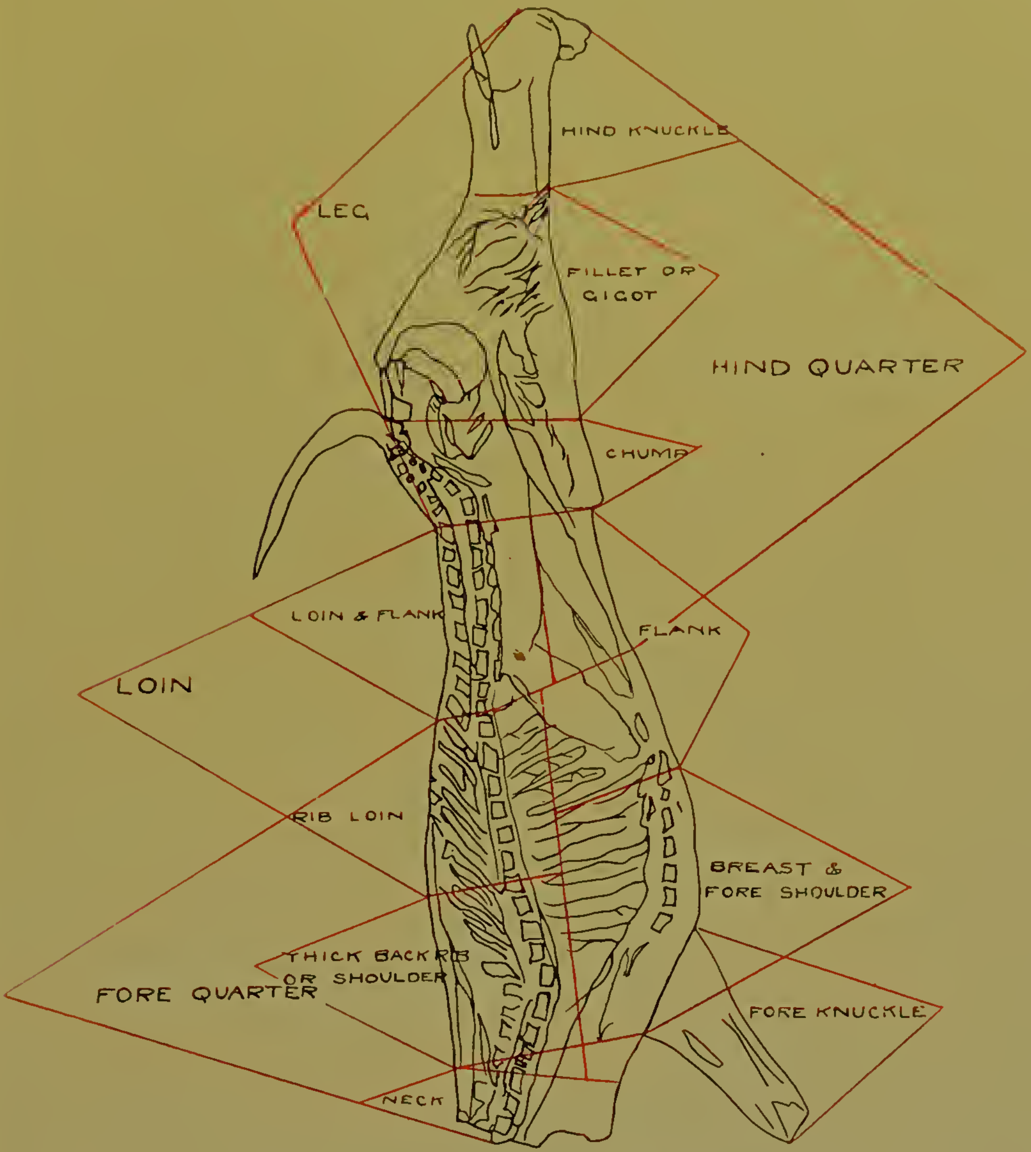
SIDE OF BEEF — *London cuts.*

Showing the parts into which it is cut by meat-purveyors in London

Trade terms

Leg of beef
Round of beef consisting of top side
  and silverside
Thick flank
Aitch-bone
Hind-quarter
Rump
Fillet
Loin (6½ bones)
Long fillet

Thin flank
Kidney and kidney-suet
Fore-rib
Fore-quarter
Middle rib
Brisket
Chuck and leg of mutton piece
Shin
Clod and sticking



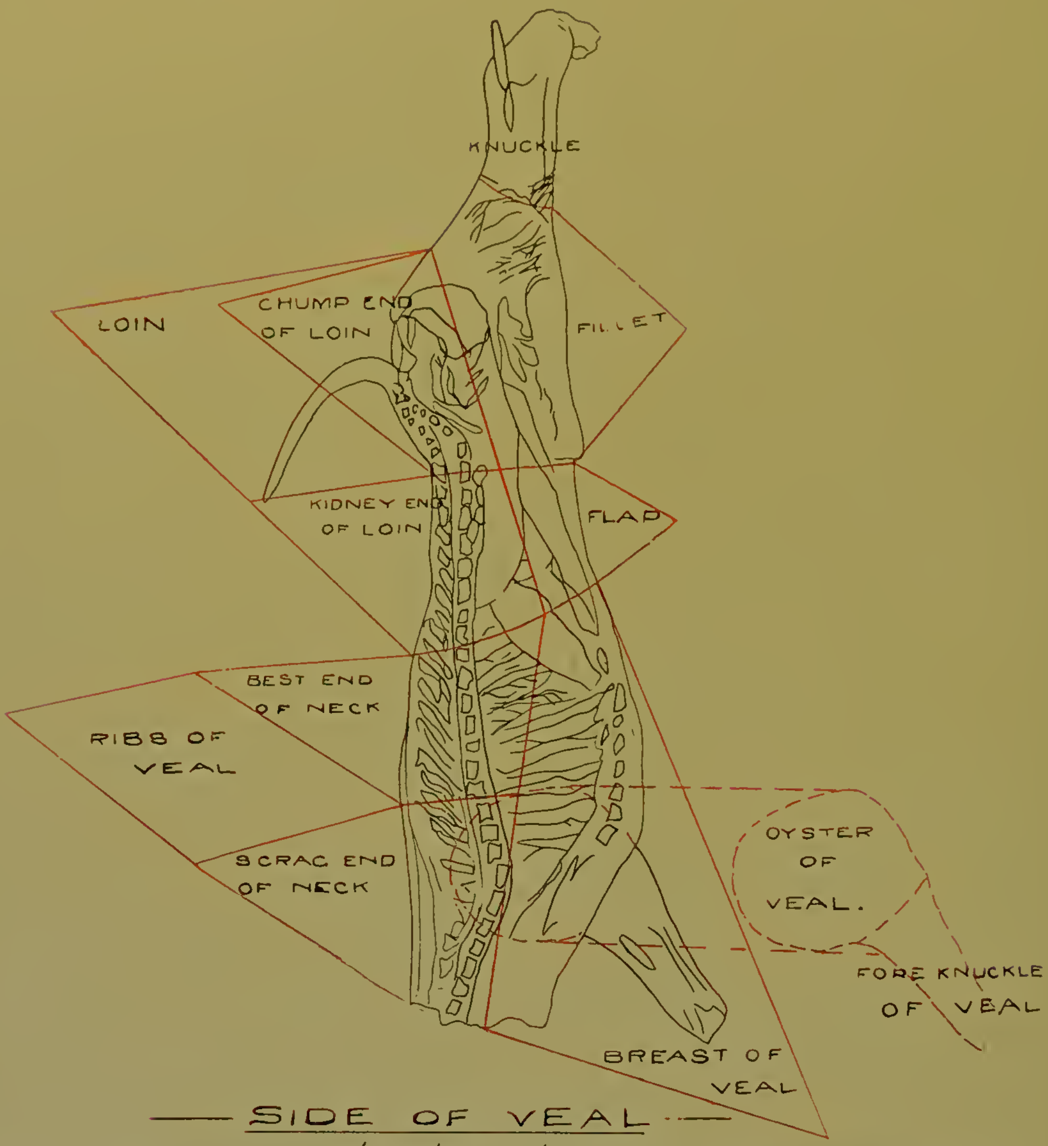
SIDE OF VEAL

Scottish cuts

Showing the parts into which it is cut by meat-purveyors in Scotland

Hind knuckle
Fillet or gigot
Chump
Leg
Hind quarter
Flank
Loin and flank

Loin
Rib loin
Breast and fore shoulder
Thick back rib or shoulder
Fore-quarter
Fore knuckle
Neck



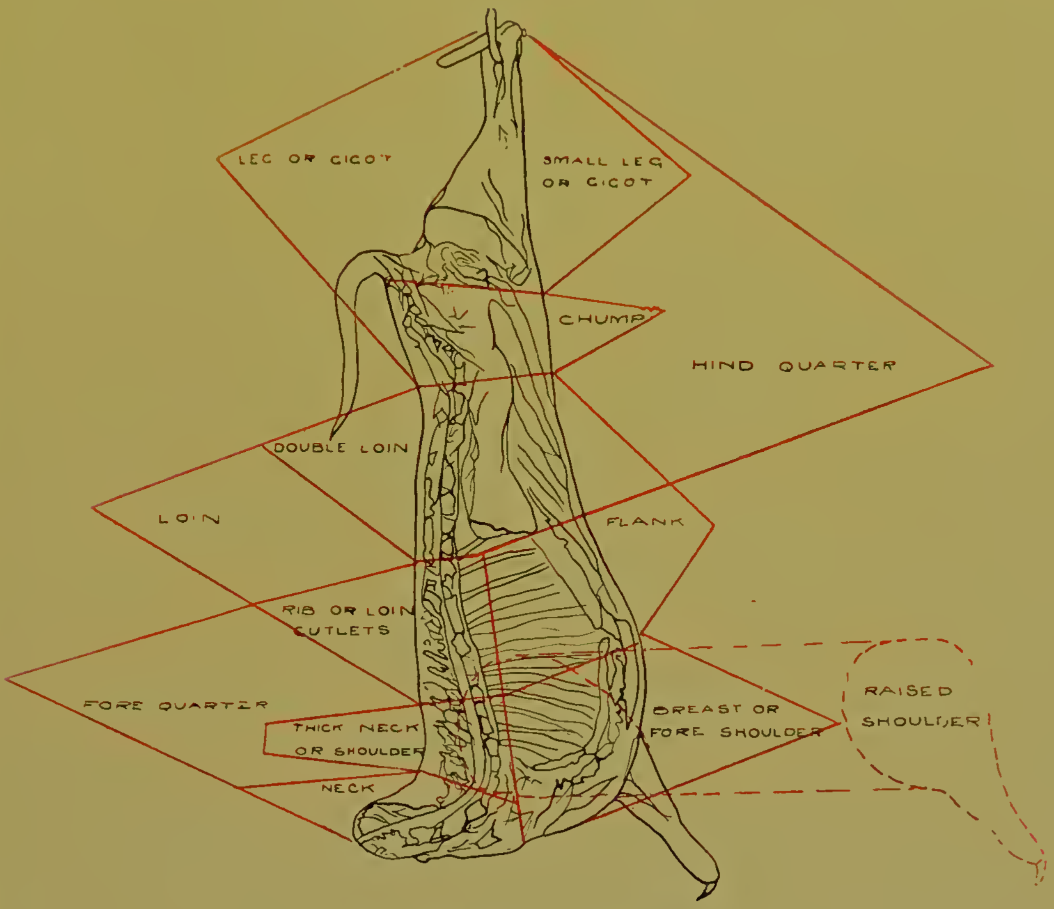
SIDE OF VEAL
London cuts

Showing the parts into which it is cut by meat-purveyors in London

Trade terms

Knuckle
Fillet
Chump end of loin
Loin
Kidney end of loin
Flap
Best end of neck

Ribs of veal
Oyster of veal
Shoulder or fore leg
Scrag end of neck
Fore knuckle of veal
Breast of veal



SIDE OF MUTTON

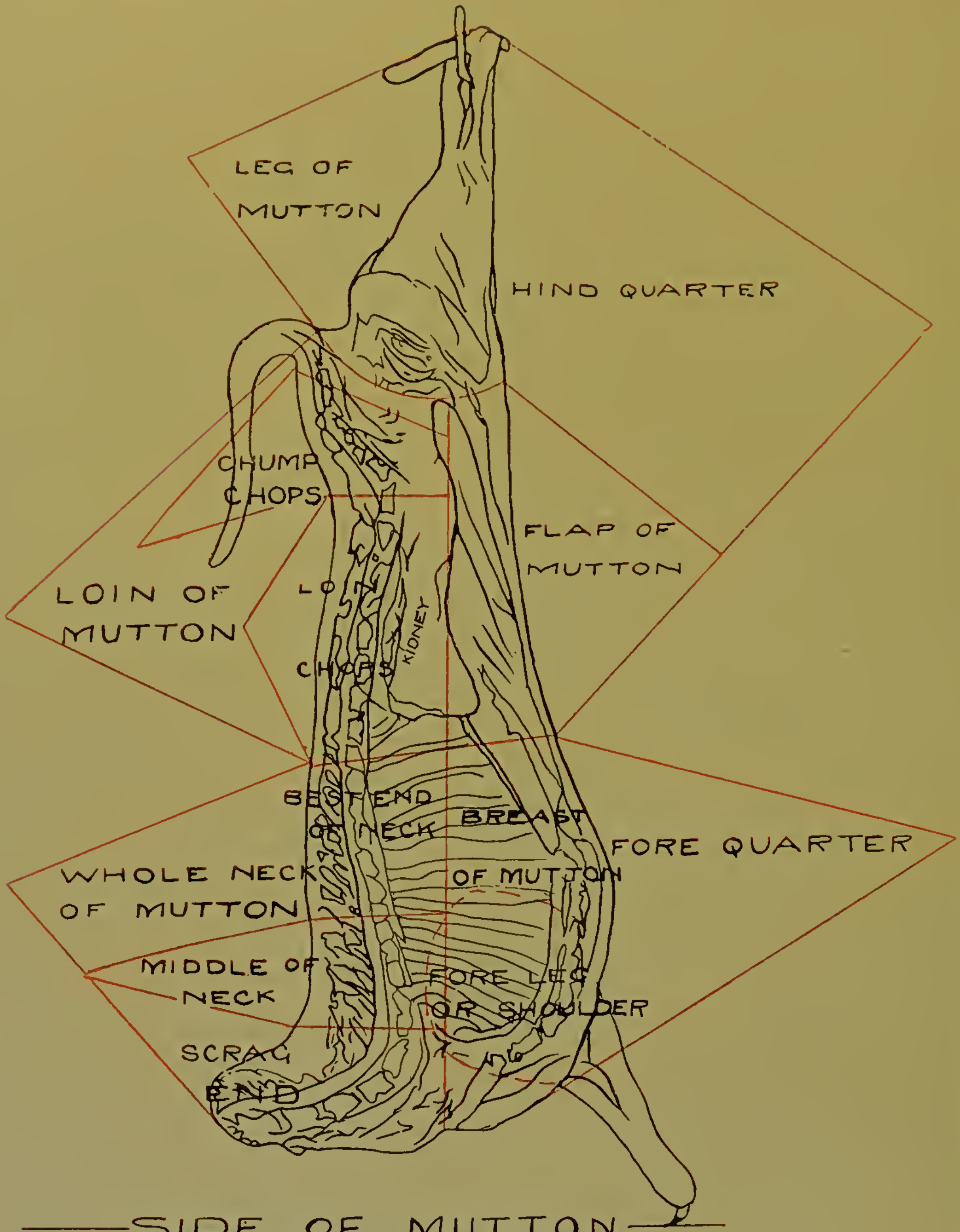
Scottish cuts

Showing the parts into which it is cut by meat-purveyors in Scotland

Trade terms

Gigot or leg
Small leg or gigot
Chump
Hind quarter
Double loin
Loin
Rib or loin cutlet

Flank
Fore-quarter
Thick neck or shoulder
Breast or fore shoulder
Raised shoulder
Neck



SIDE OF MUTTON

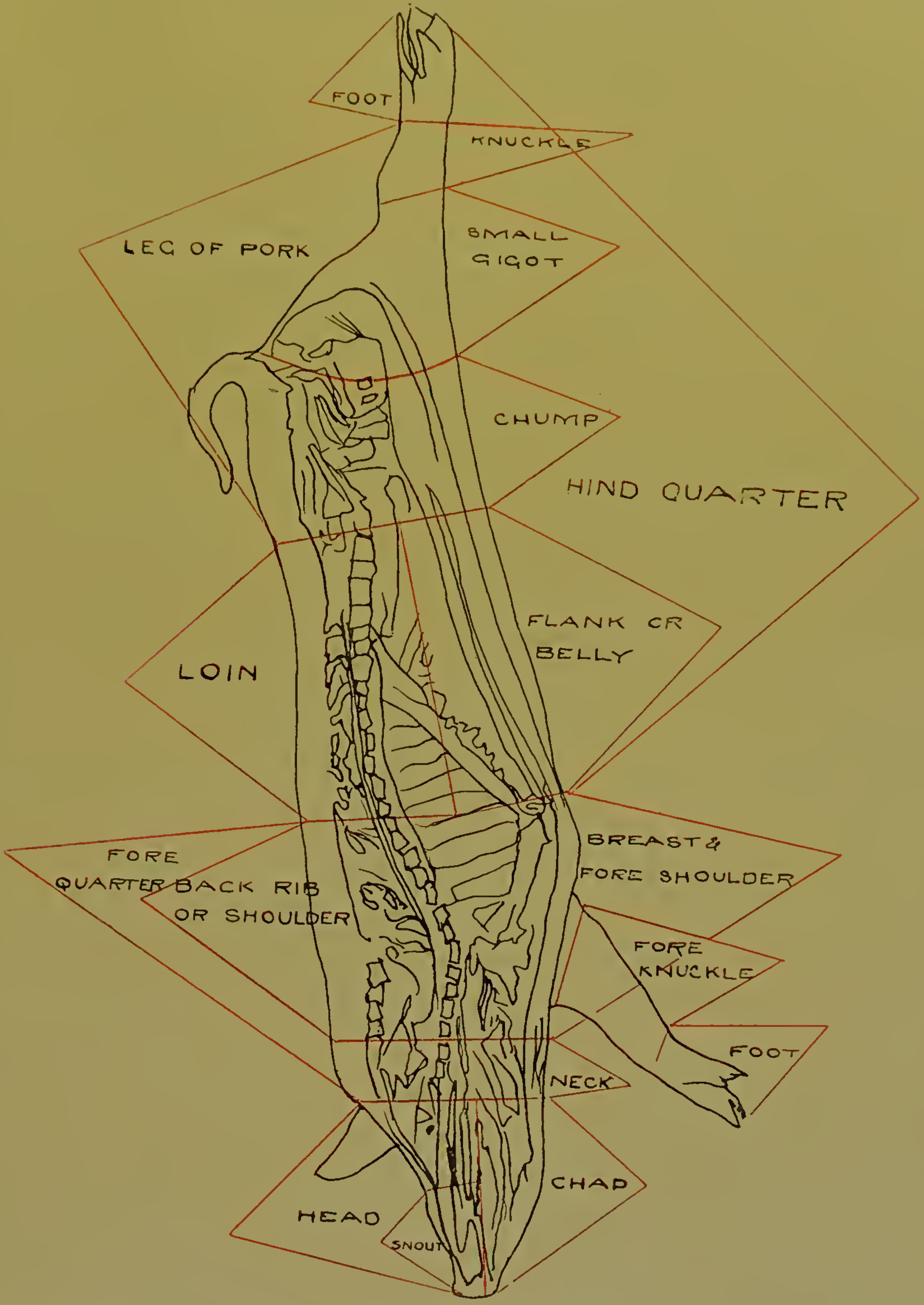
London cuts

Showing the parts into which it is cut by meat-purveyors in London

Trade terms

Leg of mutton
Hind quarter
Chump chops
Loin of mutton
Flap of mutton
Loin chops
Kidney

Best end of neck or cutlets
Breast of mutton
Whole neck of mutton
Fore quarter
Middle of neck
Fore leg or shoulder
Scrag end



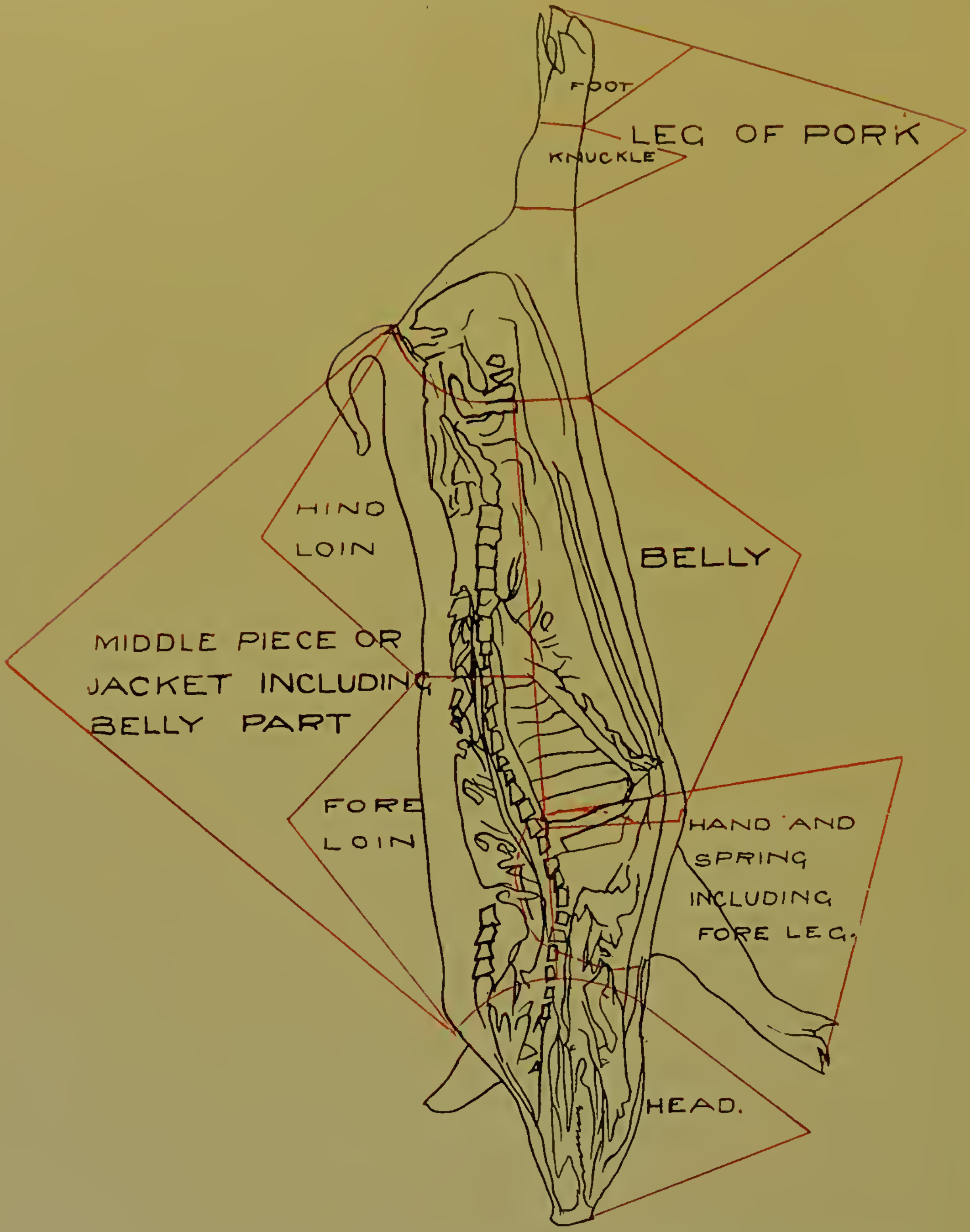
SIDE OF PORK

Scottish cuts

Showing the parts into which it is cut by meat-purveyors in Scotland

Foot
Knuckle
Small gigot
Chump
Leg
Hind quarter
Flank or belly
Loin
Fore quarter

Back rib or shoulder
Breast and fore shoulder
Fore knuckle
Foot
Neck
Chap
Snout
Head


FOOT
LEG OF PORK
KNUCKLE
HIND LOIN
BELLY
MIDDLE PIECE OR JACKET INCLUDING BELLY PART
FORE LOIN
HAND AND SPRING INCLUDING FORE LEG.
HEAD.

SIDE OF PORK

London cuts

Showing the parts into which it is cut by meat-purveyors in London

Trade terms

Foot
Knuckle
Leg of pork
Middle piece or jacket, including belly part

Hind loin
Belly
Fore loin
Hand and spring including fore leg
Head

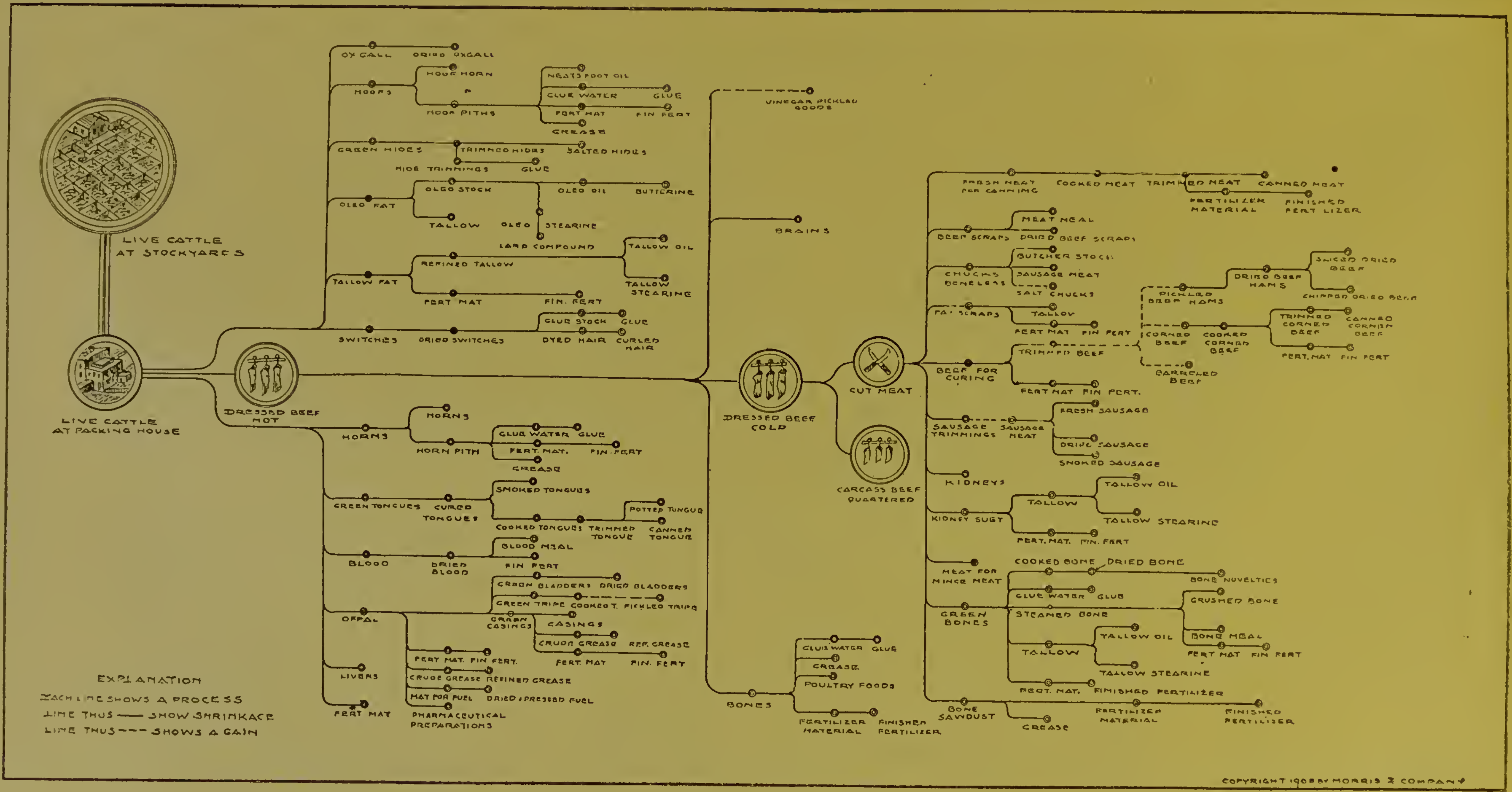


Diagram designed by Messrs. Morris and Co., Chicago, showing the various products obtainable from a bullock.

CHAPTER XII

THE CHEMISTRY OF MEAT

Animal chemistry, like that of plants, is an extremely complicated subject. The records of the investigations in connection with it would fill a considerable library, but still it cannot be claimed that anything like finality, or, indeed, in many instances, even the beginning of a comprehension of what takes place, has been attained. The materials of which animals and plants are built up are the most complex in chemical constitution with which we are acquainted. As a consequence they are very unstable and liable to be transformed into innumerable intermediate compounds in the processes of resolution by which they are ultimately reduced to their simple proximate elements: water, carbonic acid, nitrogen, phosphates, sulphur and mineral salts. These processes are for the most part outside of the scope of our present knowledge. But although we cannot follow them in detail, we have accumulated a sufficient body of fact and observation to enable us to follow them in outline; and that will be sufficient for the purposes of the present chapter.

By the agency of heat and light, plants in growing transform the proximate elements mentioned above into more complex compounds, and incorporate them into their substance. Some of these compounds are starch, sugar, cellulose, albumen and other proteins, fats, oils, organic acids, &c. Every change from a simpler element to a more complex compound involves an accumulation of energy in the form of chemical affinity.

While the building work of plants is constructive, that of animals is largely destructive.

The majority of animals find their food in plants, and even, in the carnivora the process is only once removed, as they live on animals which feed on plants. In the animal economy the plant material is partly reduced to simpler compounds and partly to proximate elements, and the energy stored up by the plants is liberated and used to transform a portion of the plant-food into the even more complex substances required to build up the bodily organs and maintain their functions. These, in turn, to supply the energy required for the work of the body, are continually reducing some of their substance to simpler forms of aggregation, so that, broadly speaking, plants build up complex structures out of simple materials by the aid of the sun, and animals maintain themselves by wholly or partially taking these structures to pieces again. Much of the energy so developed in the animal body is transformed into heat which maintains the necessary bodily temperature.

The Fuel Value of Foods. It has long been the custom to speak of food as fuel, and its use in the body as a process of combustion, and the whole course of experiment has moved in the direction of showing that this is not merely an analogy but a fact—that, in effect, nutrition is a chemical process, and that the amount of energy liberated is exactly the same as if the food actually digested and assimilated had been burnt as fuel in a fire. It is only in late years that this has been fully demonstrated, and the instrument of the demonstration was the "respiratory calorimeter" used with such effect by Atwater and his collaborators in the United States. The apparatus consists of a room large enough for a man or any animal to live in for several days if necessary. A regular supply of air is passed through the room, and most elaborate appliances are used for measuring the respiratory products (moisture and carbonic acid), and the heat given out by the subject under experiment. Food is passed in by a special trapped opening, and the solid and liquid excreta are collected and accurately weighed. The fuel value or heat given out on burning of any combustible material such as coal, wood, oil, &c., is determined in different forms of calorimeter by combustion in oxygen, either supplied as such, or in salts which readily yield it up to the combustible substance. The operation is conducted under conditions which permit of the accurate measurement of the heat evolved. The fuel value of foods is determined in exactly the same manner. They are burnt like coal in the calorimeter, and the heat given out is measured.

What Experiments have Demonstrated. To return to the respiratory calorimeter. The man or animal to be experimented on, is placed in the room and fed on an agreed-upon diet, every component of which is accurately weighed and recorded and the fuel value of an average sample determined in the ordinary calorimeter. The excreta, solid and liquid, are weighed and the fuel value determined as above, and the heat given out by the subject of experiment is determined by calculations from the records of the instruments connected to the chamber. It is obvious that experiments on this scale are surrounded with difficulties, and there is bound to be some experimental error, but this with experience has been reduced to about 1 per cent., and, within the limits of this error it has been found that the fuel-value of the excreta plus the heat measured in the respiratory calorimeter is exactly equal to the total fuel value of the food consumed. The apparatus can answer many questions. It can determine the different amounts of fuel required to maintain the body when at rest or performing various kinds of work. It can measure the value of all kinds of diets. Of course it would not be feasible, as a rule, to feed the subject on one material only during the course of even a short experiment, as this would upset the digestive system and yield incorrect results, but the diet can be varied so that one ingredient may be proportionately greater in one experimental period as compared with another, and in this way by the calculation of differences the value of each substance is arrived at. In a similar manner the values of the pure basic principles of all foods can be determined.

It may be well at this point to define the standard made use of for measuring heat in food investigations. It consists of the heat necessary to raise one kilogramme of water 1° Cent. It is equal to 3.97 or, say, 4 B.T.U.s as defined in the chapter on refrigeration (the amount of heat necessary to raise one pound of water 1° Fahr.).

Food Materials Analysed. It is not possible in the present state of knowledge to make a full and exhaustive analysis of food materials, and for practical work it is sufficient to separate the constituents into the following

Water.	Carbo-hydrates.
Protein (albuminoids).	Fats.
Mineral matter or ash.	

The above, with the exception of water, consists of groups of many substances of similar nature, and while the protein contents of a vegetable material differ considerably from those of meat, the classification is a convenient one and applies to all foods, whatsoever their origin. From some foods, however, one or more of these groups of constituents may be entirely absent.

Water is a preponderating element of diet. Most of it passes through the system unchanged, but a portion combines chemically with the other ingredients during the process of digestion.

Protein includes albumin, fibrin, legumin and the many other nitrogenous principles from which the muscular and other tissues of the body are built up.

Carbo-hydrates—starch, sugar, organic acids and other non-nitrogenous materials—are classed as heat-producers, but this is not a distinction that can now be clearly drawn.

Fats, including oils, have somewhat similar functions to the carbohydrates, but have a much higher calorific value.

Mineral matter contains iron, lime, magnesia, potash, soda, combined with phosphoric, sulphuric, hydrochloric and carbonic acids and smaller traces of other ingredients. Besides forming the bony structures of the body, it has many other functions in the animal economy which are as yet but dimly understood. The carbo-hydrates contain carbon, hydrogen, and oxygen, and the proteins contain carbon, hydrogen, oxygen, and nitrogen, but some of the fats and proteins have phosphorus and sulphur in organic combination, and these compounds are of great importance in relation to certain of the bodily functions.

Composition of the Principal Meats. On the above system the following is the composition of the principal meats with a few analyses of fish, fowl, grains, &c., for comparison. But as all these materials vary to some extent, too much reliance must not be placed on them. They are taken from various sources.

	Water.	Carbo-hydrates.	Protein.	Fat.	Mineral matter.
Beef	72.03	0.46	20.96	5.41	1.14
Veal	75.56	0.07	19.36	4.10	.91
Mutton	75.99	—	17.11	5.77	1.33
Pork	59.97	—	17.39	22.07	.91
Fowl	73.15	1.19	19.12	5.39	1.15
Partridge	71.96	—	25.26	1.43	1.39
Salmon	64.29	—	21.60	12.72	1.39
Herring	74.67	—	14.55	9.03	1.78
Cod	82.25	—	16.23	0.33	1.36
Eggs	73.67	0.53	12.55	12.11	1.12
Milk	87.22	4.48	3.66	3.62	0.68
Butter	16.03	—	0.80	83.10	0.07
Wheat	13.37	70.92	12.64	1.41	1.66
Oats	12.11	68.95	10.66	4.99	3.29
Indian corn	13.37	71.17	11.60	2.07	1.79
Haricot beans	11.24	59.48	23.60	1.96	3.66
Potatoes	76.00	21.55	1.30	0.15	1.00
Cabbage	89.97	6.71	1.89	0.20	1.23
Turnips	87.80	9.54	1.54	0.21	0.91
Apples	84.79	14.36	0.36	—	0.49

Having the analyses of the foods used in the experiments in the respiratory calorimeter before him, Atwater was able to calculate the calories yielded in digestion by protein, fat and carbohydrates of each food, and the relation to the total fuel-values of the foods as given in the following Table.

Origin.	Calories per pound digested.			Per cent. of total food value.
	Protein.	Fat.	Carbo-hydrates.	
Flesh of mammals and fish	1925	4078	—	87
Eggs	1971	4078	—	89
Milk and derivatives	1925	3987	1722	93
Average of animal food	1925	4055	1722	89
Bread and cereals	1677	3784	1858	91
Vegetables in grain	1450	3784	1836	83
Green vegetables	1314	3784	—	98
Fruits	1428	3784	1858	98
Sugar	—	—	1813	91
Starch	—	—	1632	88
Average of vegetable food	1609	3784	1813	92
Average of mixed food	1813	4033	1813	91

From these figures it is obvious that on the average about 90 per cent. of the available nutritive materials of foods are digested and made use of in the body, and that the averages for animal and vegetable do not differ very much.

A very important inquiry is that relating to the total amount of food required by the average man per day both at rest and while doing work, and what proportion of this should consist of meat and what of vegetable materials. The respiratory calorimeter determines the total calories required daily to replace waste in subjects both at rest and doing work, and by a varied series of experiments on many individuals fed in different ways the most suitable dietary in each case can be ascertained. But the subject has been approached in another way, that of ascertaining the total quantities of food consumed by a large community and dividing the items by the number of inhabitants. Gautier has applied this method in a striking manner.* Exceptional facilities exist for ascertaining the food of Paris, and he made out a statement for the eleven years 1890–1900 inclusive, using for the calculation each year the official figures of population. It is remarkable how uniform are the amounts of each class of food consumed per individual. We give below the average result from which the figures for the year 1900 are excluded, as this was the great Exhibition year when Paris teemed with unrecorded numbers of visitors.

AVERAGE FOOD PER DAY OF AN INHABITANT OF PARIS (1890–1899)

	Oz.			Oz.
Bread				14.2
Pastry and cakes				0.7
Butcher's meat	6.22	gross.	Bone and feather deducted	7·7
Pork, salted and cooked meats	1.07			
Poultry, game	1.10			
Fish	1.19			
Eggs (less shells)				·9
Cheese				·3
Butter, oil, fat and lard				1.0
Fresh fruits				2.5
Green vegetables				8.9
Dried vegetables				1.4
Potatoes, rice				3.6
Sugar				1.4
Milk				7.6
Wine				18.4
Cider, perry, hydromel				0.4
Beer				1.0
Brandy, liqueurs, &c.				0.7
Kitchen salt				—
Total				71.4
Bone, feathers and egg-shells				2.0
				73·4

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* "Diet and Dietetics."

Of this total the net animal foods amount to 24.5 per cent., the meat, poultry and game accounting for about 10 per cent. net. It is assumed that the larger amounts of food required by workmen balanced the smaller quantities consumed by women and children, and that the above figures fairly represent the requirements of the average adult man in a state of repose. This diet contains the following amounts of the pure nutritive principles:

Protein	3.6 oz.
Fats	2.1 ,,
Carbohydrates	14.2 ,,

The method of observing, weighing and analysing the food consumed by selected typical individuals has been followed by many observers, and the figures below are the average for a considerable number of men—professional and workers and women in several countries.

Protein	3.9 oz.
Fats	2.8 ,,
Carbohydrates	14.1 ,,

With the respiratory calorimeter the following are the results:

Protein	3.9 oz.
Fats	2.1 ,,
Carbohydrates	15.1 ,,

The average of the three results is:

Protein	3.8 oz.
Fats	2.3 ,,
Carbohydrates	14.5 ,,

Going back to Atwater's coefficient of calories and applying those for average mixed diet to the above, we obtain the following:

3.8 × 1813 = 6889
2.3 × 4033 = 9276
14.5 × 1813 = 26288

42453 ÷ 16 (lb. to oz.) = 2628 calories as the amount required per adult per day. A man doing hard work needs about 1200–1400 additional, and with fatiguing work in cold climates the calories may require to be doubled.

Why Vegetables and Fruits are Necessary in Diet. It is generally agreed among physiologists that of the total protein in food from 40 to 60 per cent. may be derived from animal sources, meats and certain vegetable foods—bread, for instance, which contains organic phosphorus and sulphur, yields when burnt, an acid ash, the phosphorus and sulphur being oxidised to phosphoric and sulphuric acids which the bases present are not sufficient to neutralise. The same thing happens in the body. Fresh vegetables and fruits, although they do not contribute much nourishment, supply organic acids (malic, tartaric, citric, oxalic, &c.) which are combined with bases (lime, potash, soda, magnesia). When burnt either in a fire or in the system the organic acids are consumed, leaving the bases as carbonates which combine with the excess of phosphoric and sulphuric acids and neutralise them. This is the reason why fresh vegetables and fruits are necessary to secure a proper balance in diet.

CHAPTER XIII

THE COOKING OF MEAT

The changes which occur in meat on cooking may naturally be grouped into two classes: (1) losses in cooking, and (2) effects of cooking on digestibility.

Thudicum in 1895 published the results of a large number of observations on the losses in roasting, baking and boiling meat, of which the following is a summary:

Kind of meat.	How cooked.	No. of experiments.	Average loss per cent.
Beef	Boiled .	28	26½
,, ...	Roasted .	19	32
,, ...	Baked .	9	32
Mutton, legs	Boiled .	27	21½
,, shoulders . . .	Roasted .	35	31½
,, loins . . .	,, .	16	35½
,, necks . . .	,, .	10	32⅓

By far the most elaborate experiments on the losses in cooking are those of Professor Grindley, of the University of Illinois, with different assistants, from 1898 till 1903. The results are contained in Bulletins 102 and 141 of the United States Department of Agriculture. We cannot quote even the summaries of the voluminous tables of analyses and experiments and must content ourselves by reproducing the statement of general conclusions at the end of the second bulletin.

The General Conclusions. These are: "Much more study is required of the losses dependent upon the cooking of meats and of the chemical changes involved before definite or final deductions can be drawn. Some conclusions, however, seem warranted. In general, it may be said that the data given on the preceding pages confirm the conclusions stated in a previous bulletin * upon this subject, and also leads to some further deductions. Briefly stated, the results of all the tests indicate that:

"(1) The chief loss in weight during the boiling, sauté-ing and pan-broiling of meats is due to water removed by the heat of cooking. In the roasting of meats the chief loss is due to the removal of both water and fat.

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* United States Department of Agriculture, Office of Experiment Stations, Bul. 102.

"(2) The losses of nutritive material in the pan-broiling of meats are very small as compared with the losses which take place in boiling, roasting and sauté-ing.

"(3) When beef was cooked in water in these experiments, 3.25 to 12.67 per cent. of the nitrogenous matter, 0.60 to 37.40 per cent. of the fat, and 20.04 to 67.39 per cent. of the mineral matter of the original uncooked meat were found in the broth. The nutritive material thus removed has been designated as a loss, but is not an actual loss if the broth is utilised for soup or in other ways.

"(4) The experiments here reported show that when meat is sautéd 2.15 per cent. of the nitrogenous matter and 3.07 per cent. of the ash occurring in the uncooked meat were taken up on an average by the fat in which the meat was cooked, while the cooked meat contained 2.3 times more fat than before cooking.

"(5) When the meats were roasted, 0.25 to 4.55 per cent. of the nitrogenous matter, 4.53 to 57.49 per cent. of the fat, and 2.47 to 27.18 per cent. of the mineral matter present in the uncooked meat were found in the drippings.

"(6) Beef which has been used for the preparation of beef-tea or broth has lost comparatively little in nutritive value, though much of the flavouring material has been removed.

"(7) In the boiling of meats, the fatter kinds and cuts, other things being the same, lost less water, nitrogenous and mineral matter, but more fat than the leaner kinds and cuts.

"(8) In cooking meats by boiling, sauté-ing, pan-broiling and roasting, the losses increased in proportion to the degree of cooking. In other words, the longer the time and the higher the temperature of cooking, other things being the same, the greater the losses resulting.

"(9) As a rule, the larger the piece of meat cooked by the methods of boiling and roasting, the smaller were the relative losses.

"(10) The experiments indicate plainly that different cuts of the same kind of meat behave very differently as regards the amount and nature of the losses which they undergo when cooked in hot water.

"(11) Thorough investigation confirms the conclusion that when meat is cooked in water at 80° to 85° Cent., placing the meat in hot or cold water at the start has little effect on the amount of material found in the broth.

"(12) The nature of the nitrogenous constituents and the so-called 'other substances' of meats and broths is as yet not fully understood, although a very large amount of time has been devoted to the study of these groups in connection with this investigation."

While still noting the losses of meat on cooking, the inquiry 1903–4 * takes account also of the influence of cooking on the composition and nutritive value, the nature of the changes resulting from different methods of cooking and the composition of the water-extracts of raw and cooked meats. The methods of analysis were improved (1) by

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* *Bulletin*, No. 162.

analysing the fresh instead of the usual air-dried samples special modifications of processes being devised for the purpose; (2) the preparation and examination of cold-water extracts of both raw and cooked meats.

The Lessons from the Experiments. The principal conclusions which can be drawn from these studies of meat and meat-products are the following: Meats of different kinds and cuts may be analysed directly and with accuracy—that is, without being first previously air-dried. The soluble matters in meats may be completely removed by extraction with cold water and the preparation and analysis of such cold-water extracts is of great importance in studies of the true value of flesh foods. The total proportion of raw meat which is soluble in cold water is considerable, the average results showing that the cold-water extract contains about 2.3 per cent. proteid, 1 per cent. nitrogenous extractives, 1.6 per cent. non-nitrogenous extractives, 0.7 per cent. nitrogen, and 0.8 per cent. ash. None of the fat present in the meat is dissolved by cold water. The proportion of each nutrient present in the original flesh which is dissolved in cold water is, on an average, proteid, 13 per cent.; organic extractives, including both nitrogenous and non-nitrogenous compounds, 100 per cent.; ash, 81 per cent.; total nitrogen, 22 per cent. Of the nitrogen compounds soluble in cold water, 46 per cent. is coagulated by heat. The nitrogen present is about equally divided between proteid and non-proteid bodies.

Meats cooked by boiling are less soluble in cold water than are raw meats, the average amount of nutrients recovered in the extract as compared with the total weight of the meats used being 0.4 per cent. proteid, 0.6 per cent. nitrogenous extractives, 0.8 per cent. non-nitrogenous extractives, 0.3 per cent. nitrogen, and 0.4 per cent. ash. The average ratio of non-proteid to proteid nitrogen is as 1 : 0.31. Expressed as percentages of the amount of each nutrient originally present, the average values for the cold-water extract of cooked meats are 1 per cent. proteid, 100 per cent. extractives, including both nitrogenous and non-nitrogenous compounds, 67 per cent. ash, and 1 per cent. nitrogen. As in the case of raw meat, no fat is dissolved by the cold water.

Different Methods in Cooking. The different methods commonly followed in cooking meat in hot water vary somewhat as to time and temperature of cooking, but the resulting cooked meats are quite similar as regards composition and also as regards the proportion of their constituents which are soluble in cold water.

Meats cooked by dry heat, as in roasting, broiling, sauté-ing and frying, are on an average 2.4 times more soluble in water than boiled meats, but are only a little more than half as soluble as raw meats. The results show that on an average cold water removes the following percentage amounts from meats cooked by dry heat: proteid 0.7, nitrogenous extractives 1.3, non-nitrogenous extractives 1.6, nitrogen 0.5 and ash 1 per cent. Considered on a water-free basis, roast meats contain about 2.3 times as much soluble proteid and non-nitrogenous extractives and 2.5 times as much nitrogenous extractives and ash as boiled meats.

The more pronounced flavour of meats cooked by dry heat as compared with those cooked in hot water is without doubt due to the larger proportion of soluble constituents which the former contains. As regards the loss in weight when meat is cooked in hot water, the average value shows that it is equal to from 10 to 50 per cent. of the total weight of the fresh meat used, the average being about 34 per cent. The amount of water removed by the heat of boiling ranges from about 18 to 69 per cent., the average being 45 per cent. of the amount originally present. The total protein removed in the broth varies from 3 per cent. to 13 per cent., averaging 7 per cent. The proportion of fat originally present in the raw meat which is recovered in the broth varies from 0.6 to 37 per cent., and the proportion of mineral matter from 20 to 67 per cent., averaging not far from 45 per cent. The nutrients in the broth expressed as percentages of the total weight of the uncooked meat on an average equal water 31, proteid 1, fat 1, and ash 0.5 per cent. The fatter kinds and cuts of meat lose less water, proteid and mineral matters, but more fat than leaner kinds of meat. The proportion of nutrients extracted in the broth is directly proportional to the length of time and the temperature of the cooking period.

The Larger the Piece, the Smaller the Loss. Different cuts of some kinds of meat behave differently as regards the nature and amount of the losses they sustain when cooked in hot water. On an average, the larger the piece the smaller the percentage losses. When meat is cooked in water at 80° to 85° Cent., placing the meat in hot or cold water at the start has little effect on the amount of material recovered in the broth. Beef used in the preparation of beef-tea or broth has lost comparatively little of its total nutritive material, though most of the constituents which give flavour have been removed. The experimental data indicate that on an average 72 per cent. of the nitrogenous organic extractives originally present in beef is removed during boiling, and that the average of non-nitrogenous organic extractives removed is also 72 per cent. When meats are cooked by dry heat the losses sustained are much smaller than when cooked in hot water, being, on an average, water 35, nitrogenous extractives 9, non-nitrogenous extractives 17, fat 7 and ash 12 per cent. On an average there was an apparent gain of 4 per cent. proteid, this apparently anomalous value being probably due to unavoidable faults in the experimental methods or some similar cause.

As regards the composition of complete or unfiltered meat broths, the average results vary, the total solid matter containing from 1 to 10 per cent. of the total quantity of meat used. On an average the percentage composition of a large number of broths was, water 97, total solids 3, proteid 0.3, nitrogenous extractives 0.6, non-nitrogenous extractives 0.7, total organic extractives 1.3, fat 1.3 and ash 0.5 per cent. On an average 0.24 per cent. of the total nitrogen was present as proteid and 0.18 per cent. as non-proteid bodies. The clear filtered broths contained less of the important food elements, *i.e.*, proteids and fat, than complete or unfiltered broths, but practically the same amounts of the different extractive bodies and ash. In other words, they have less food value but fully as much flavour as the unfiltered broths, provided the fat is removed in both cases. Meat fat possesses more or less distinctive flavour, and, if present, modifies the flavour of the broth. Both filtered and unfiltered broths have a low food value as compared with the meats from which they are made, or as compared with the meats cooked by dry heat or in hot water. This is obvious when it is remembered that broth or soup is made up largely of water.

How Cooking Affects Nutritive Value. The small amount of nutritive material in broth and soup is chiefly in the form of organic extractives. The richness of the broth increases as the size of the pieces of meat used in making it decreases. An increase in the time of cooking also increases the amount of nutrients found in the broth. The broth is very little richer when made from bones as well as meat, the chief nutrients thus added being fat and soluble proteid.

In general, the various methods of cooking materially modify the appearance, texture and flavour of meat, and hence its palatability, but have little effect on total nutritive value. Whether it be cooked in hot water, as in boiling or stewing, or by dry heat, as in roasting, broiling, sautéing or frying, meats of all kinds have a high food value when judged by the time and amount of nutritive ingredients which are present.

The effect of cooking on the digestibility of meat has been the subject of separate investigation.* The only satisfactory way of testing this is by experiments on men, and this method was adopted, the subjects being fed on various diets, the digestibility of the ingredients of which, with the exception of meat, was known. The subjects were allowed to eat as much as they wished, the quantities being weighed and the total digested was ascertained by examination and analysis of the fæces, the urine also being analysed. Obviously this method gives only the total digestibility, and an attempt was made by artificial digestive experiments to ascertain the facility or otherwise with which the different meats were digested.

Digestion Experiments on Men. On twenty-three natural digestion experiments with men the same kind of meat—beef (round)—cooked in various ways, was eaten with several other common food materials in a rather varied diet. The average digestibility of the nutrients of the total diet was as follows: protein 93, fat 98, and carbo-hydrates 97 per cent. These coefficients agree very closely with those found in the average of several hundred digestion experiments with varied diet.

In these experiments differences in method of cooking the meat had no appreciable effect upon the proportions of nutrients digested and absorbed from the total diet.

In forty-four experiments different kinds of meat—beef, veal, mutton, and pork—cooked in various ways, were eaten with two or three other common food materials in a very simple diet, and the digestibility of the meat alone was determined. In the average of the results of these experiments the digestibility of the protein was 98 per cent. and of the fat 98 per cent.

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* *Bulletin*, No. 193, 1907.

Differences in the results obtained with different kinds of meat, or with the same kind of meat cooked in different ways, were too small to be of any practical significance.

The relative fatness of the meat had no appreciable effect upon the thoroughness of digestion, the nutrients of the very fat meat being digested as completely as those of very lean meat, including that from which, in some cases, part of the visible fat had been removed before cooking.

In short, all the kinds and cuts of meat were very thoroughly digested, whatever the method of cooking.

The above-mentioned coefficients of digestibility of the nutrients of meat are those derived according to the usual method from the quantity of each in the food and the total quantity in the corresponding fæces. When allowance was made for the metabolic products in the fæces, the results obtained indicated that the nutrients of the meat were completely digestible.

It is commonly said that meats of different sorts vary decidedly in digestibility; for instance, that red meat is less digestible than white meat or beef than pork, or that a cheap cut is less digestible than a tender steak. As regards the thoroughness of digestion the results of the extended series of tests reported show that such differences do not exist in any appreciable degree, and that meat of all kinds and cuts is to be classed with the very digestible foods.

Ninety-nine artificial digestion experiments made for the purpose of testing the relative ease of digestion of different kinds and cuts of meat, cooked in different ways, do not warrant any sweeping deductions. So far as can be judged from the results obtained under the experimental conditions the meat seems to be quite easily digested. About 80 per cent. of the meat protein was digested in the first hour and nearly 90 per cent. within two hours, whatever the kind of meat or the method of cooking, though there were considerable variations from these proportions in the individual experiments. The differences with the several kinds of meat, or with meat cooked in a variety of ways, are very small or very irregular, and in some cases are apparently contradictory, so that it cannot be said that they indicate any difference that could be attributed to the factors mentioned.

CHAPTER XIV

THE RELATIVE VALUE OF FRESH AND COLD-STORES MEAT

The effects of chilling, freezing and holding meat in cold storage is one of considerable interest, especially in this country where we now depend to such an extent on this class of produce. The matter attracted attention even before the frozen-meat industry had become a regularly organised business. As the methods of refrigeration and the proper regulation of temperatures and humidity and the keeping pure of the air of cold-rooms have all shown marked improvement the earlier observations are probably not now reliable. This may explain why the French chemists in 1874, and even up to 1889, found that while meat stored at 29° to 37° Fahr. would keep indefinitely as far as putrescibility was concerned and its tenderness increased, at the same time a peculiar fatty odour developed towards the end of the second month which affected the flavour. Later observers certainly note, in some cases, a distinction in the odour of cold-stored as compared with fresh meat, but not as a matter of any particular account, and in general they agree that cold-stored meat is more tender, juicier and quite as nutritious as fresh meat. It is to the United States, with its splendid arrangements for practical experiments, that we turn for the latest information on this subject. It has been dealt with by Emmett and Grindley in continuation of the long series of experiments undertaken by the latter in connection with the chemistry of meat. The work done up to date is published in two papers.* In the experiments on beef the greatest care as usual is taken to obtain representative samples. The history of the cattle used is detailed and full control of the carcases is taken from the beginning. They were cut up into the usual commercial joints by an experienced cutter. Minute and careful analyses were made of the samples and every care taken to see that these were representative. The conclusions to the first paper are as given in the following paragraphs.

Experiments on Beef. In making a comparison of the chemical composition of fresh and cold-storage flesh, the samples of which were procured under known conditions and either from the same animal or the same lot of animals, it was found:

(1) The method, as used in this laboratory, was sufficiently accurate to detect changes which occurred in flesh during cold storage.

(2) In the case of the refrigerated beef which was stored for 22 days, the averaged data indicate:

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* *Journal of Indust. and Eng. Chemistry*, Vol. I., Nos. 7 and 8, July and August 1909.

(*a*) That there was no loss of water.

(*b*) That the percentage of the water-soluble solids, the soluble, insoluble and total protein, the non-coagulable protein, the nitrogenous and total organic extractives, the forms of ash, the total nitrogen and the total phosphorus, all remained practically unchanged.

(*c*) That the only consistent real changes were a distinct increase in the total soluble and the soluble inorganic phosphorus, being 8.0 and 17.9 per cent. respectively, and a decrease of 8.3 per cent. in the non-nitrogenous organic extractives.

(*d*) That the nutritive value of the meat was unaltered.

(3) In the case of the refrigerated beef which was stored for 43 days, the averaged data show:

(*a*) That there was a loss of water amounting to 1.3 per cent.

(*b*) That this loss of water, causing a proportional increase in all the other constituents, produced differences in some instances which were sufficient to overbalance the amounts in the fresh samples.

(*c*) That the ratio of the non-protein to the protein nitrogen in the meats was lower.

(*d*) That when allowance was made for the loss of moisture, the additional changes which occurred in cold-storage consisted in a definite increase in the soluble dry substance, the nitrogenous, non-nitrogenous, and total organic extractives, the total soluble nitrogen, the soluble inorganic phosphorus, and a slight increase in the soluble coagulable and total soluble protein nitrogen, and also in the insoluble and total nitrogen.

(*e*) That the chemical changes in the 43-day refrigerated meats were greater in number than in the 22-day samples, yet as far as nutritive value was concerned, the former showed an increase in the organic extractives and soluble protein, and but an insignificant decrease in the total protein.

In the second paper certain cuts from the same carcases are cooked by boiling and roasting and elaborate analyses made of the cooked meat and the broth and drippings.

The Effect of Storage. Having considered in detail the chemical composition of the cooked meats, both in per cent. of the fresh substances and the uncooked meats themselves, the nature of the losses and the proportional distribution of the various constituents in the cooked meats and the broth and drippings which resulted from the boiling and roasting of the samples of lean beef loin which had been held in cold storage for 6 and 43 days, the following summary shows the effect which seems, in these cases, to have been produced during the interval of 37 days of storage.

First, from the chemical examination of the cooked meats, obtained from the respective 6- and 43-day-storage samples, the average data in each case shows when calculated to the fat-free basis and then to the same moisture content, that the cooked meats from the longer stored sample contained, when compared with those from the 6-day sample, 11.3 per cent. more of soluble dry substance, 41.6 per cent. loss of coagulable soluble protein, practically the same percentage amount of total soluble protein, and 1.9 per cent. less of total protein ; that the percentage of the nitrogenous and non-nitrogenous organic extractives were each 17.4 higher ; that the ash content was about the same ; that the percentage of total soluble nitrogen was 14.7 per cent. higher, while that for the total nitrogen was but 0.5 per cent. lower ; that the percentage of the soluble inorganic, the total soluble and the total phosphorus were respectively 22.9, 11.1 and 10.5 per cent. higher and that the ratio of the soluble non-protein nitrogen to the total protein nitrogen was 1 : 12.3 for the samples from the 6-day meat and 1 : 10.5 for those from the 43-day meat.

Secondly, the composition of the cooked meats calculated in per cent. of the uncooked showed in general : that of the samples obtained from the 6- and 43-day-stored meats, those from the latter lost 3.34 per cent. less during the process of cooking ; they contained 2.24 per cent. more of water and hence were juicier ; their soluble, insoluble and total dry substance showed a percentage increase over the 6-day meat of 13.4, 2.5 and 3.7 per cent. respectively ; the percentage of insoluble and total protein was practically the same as those in the 6-day samples ; the nitrogenous, non-nitrogenous and total organic extractives were respectively 15.7, 15.3 and 15.5 per cent. greater ; even after allowing for the differences in the broth and drippings, the fat showed an increase amounting to 8.4 per cent. of the total in the samples from the 6-day meat ; the percentage of total ash was 7.0 per cent. greater ; the soluble inorganic and the total soluble phosphorus showed percentage gains which were respectively 24.5 and 12.7 per cent. of the total amounts in the other samples ; and the total soluble nitrogen was 16.9 per cent. higher, while the percentage of total nitrogen was about the same as in the meat from the 6-day sample.

Facts from Tests. Thirdly, the proportional amounts of the various nutrients which were retained in the corresponding cooked samples from the 6- and 43-day cold-storage meats, showed the following facts in regard to the samples which were from the meat that was kept in cold storage for the longer time. Of the total amounts of constituents found by summing the composition of the respective cooked meats and the corresponding broths and drippings, these meats retained on an average 3.97 per cent. more of water ; 4.53 per cent. more of soluble dry substance ; 5.05, 4.88 and 4.98 per cent. more of nitrogenous, non-nitrogenous and total organic extractives respectively ; 2.98 per cent. more of fat ; 5.12 and 5.06 per cent. more of soluble and total ash ; 3.63, 6.52, 6.74 and 4.29 per cent. more of soluble inorganic, soluble organic, total soluble and total phosphorus respectively. Further, these meats lost practically the same proportional amounts of the insoluble and the total forms of dry substance, protein and nitrogen as did those from the 6-day sample, being respectively for the cooked meats from the 43- and 6-day samples 98.86 and 98.31, 95.63 and 94.63, 99.53 and 99.63, 98.41, 98.34, 99.54

and 99.61 and 96.32 and 96 per cent. In comparing the boiled and roasted meats, it was seen that in every case where there was any appreciable difference between the storage samples, the former cooked meats showed the effect to a greater degree.

The General Results. Finally, it may be stated in general, that many of the differences between cooked meats from the samples which were held in cold storage for 6 and 43 days corresponded to those which were found to exist for the uncooked refrigerated samples.

That the cooked meats from the 43-day-storage sample lost less in cooking either by boiling or roasting than did those from the 6-day sample, the broths and drippings in these cases being, on the average, lower in their percentage content of soluble, insoluble and total dry substance, of organic extractives, of soluble protein, of soluble ash and of fat.

That the cooked meats from the longer-stored sample were higher in their percentage content of moisture and were therefore juicier, higher in soluble and insoluble dry substance, in nitrogenous, non-nitrogenous and total organic extractives, in fat, in total ash, and in soluble inorganic, total soluble and total phosphorus. Further the percentages of total nitrogen, insoluble and total protein were practically the same as were those for the samples from the 6-day-storage meat. Therefore, the cooked meats from the 43-day samples, judging from the chemical composition, were at least as nutritious as were those from the samples stored for the shorter period of time.

These experiments only deal with chilled beef. The whole subject of the effects of cold storage on food of various kinds—poultry, eggs, rabbits, &c., as well as meat—is attracting much attention at the present moment. It is in the transition state and many investigations are in process of being carried out which will doubtless add to our knowledge.

CHAPTER XV

THE PICKLING OF MEATS

There is very little literature on the subject of the pickling of meats, but from scanty references in ancient works, it is quite clear that the process has been known since the earliest of times. It is only, however, within the last fifty years that the business has been reduced to an organised industry.

The ancient process consisted simply of throwing meat into a haphazard solution of salt and water, and sometimes a little saltpetre was added as an antiseptic and, occasionally, sugar was used as a flavouring material and also because of its preservative qualities.

The object in pickling meats was, and is, to preserve them from one season to another. In the primitive condition, the constant use of meats was restricted to the wealthy, but, owing to the absence of cooling appliances, it was impossible to handle meats safely in the summer-time, and consequently meat of all kinds was put in salt, so as to preserve it for a lengthy period. This salt meat could be kept from the summer-time right through the winter, as the absence of food for live-stock during the winter months made it difficult to maintain any large herds for the purpose of supplying food.

At the present day the pickling of meats derived from cattle, and pigs is carried on to an enormous extent, not only by small shopkeepers, but by farmers, provision dealers and in large factories.

Putrefactive Germs in Meat. In so far as the pickling of meats in a shop is concerned, this has often been looked upon as a necessary process so as to utilise portions of carcases that are left unsold and would therefore be liable to decomposition. It is quite a mistake, however, to suppose that pickling will either restore meat that is partially decayed or destroy all the putrefactive organisms which may be present. There is no doubt that solutions of salt of various densities have an inhibitory effect upon many micro-organisms, and, in this way, pickle solutions having different densities or percentages of salt present, have become recognised as being applicable to different articles preserved by the pickling process, and practical experience has shown that any solution containing 10 to 25 per cent. of salt arrests, to a certain extent, the growth of some of the putrefactive germs. Others, however, of a pathogenic or disease-producing character, are entirely untouched by such solutions, and, according to Forster, quoted by Ostertag,* "pathogenic staphylococci, the streptococcus of erysipelas and the bacilli of swine erysipelas, remain alive for weeks and months when pure cultures of these micro-organisms are covered with salt. Tubercle bacilli in cultures treated in the same manner proved virulent after two months. Pieces of tuberculous organs finely minced also proved to be virulent after lying in salt brine for eighteen days. Anthrax bacilli were destroyed in from eighteen to twenty-four hours. Anthrax cultures, however, containing spores, retained their virulence for months, despite treatment with salt. Salting the meat of diseased animals has, therefore, by no means the high value which is commonly ascribed to this method of preservation."

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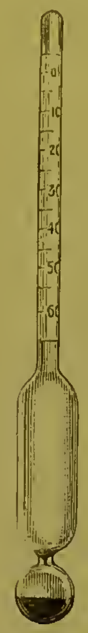
* "Hand Book of Meat Inspection." By Dr. Robert Ostertag, 1907.

Different solutions of salt are used for specific purposes, and it is necessary to have a ready means of ascertaining whether such solutions are of the density required or not. The following Table, therefore, will be of use in enabling the densities to be ascertained by means of either a salinometer or a Beaumé or Twaddell hydrometer. The degrees on these three different instruments are given in parallel columns and are translated into the specific gravity of the liquid and also the percentage of salt to which such specific gravities correspond :



Salinometer, for Testing the Density of Pickles

Salinometer.	Beaumé.	Twaddell.	Specific gravity, water at 60° F. being taken as 1.	Per cent. of salt (NaCl) by weight per cent.
20	5	7	1.037	5
40	10	15	1.073	10
60	15	23	1.115	15
80	19	30	1.150	20
100	24	38	1.191	25

As 100 parts of water at 15° Cent. (59° Fahr.) dissolve 36 parts of salt, which is equal to a brine containing 26.5 per cent. of salt (NaCl), it is obvious that the last line in the above Table refers to a practically saturated brine. Of course, the figures will be modified by temperature, and by addition of other chemicals and by impurities. At 100° Cent. (212° Fahr.) 100 parts of water dissolve 39 parts of salt (NaCl), which is equal to 28 per cent.

The Density of Pickling Solutions. Each of the instruments named is of a purely arbitrary character, so that it is quite immaterial which one is used for the purpose of ascertaining the density. The salinometer, however, which is simply a weighted glass bulb, is so graduated that the divisions are reckoned as parts of a hundred, 100° being the total saturation of the liquid, and as a convenient instrument it is preferred by most pickled-meat makers. In order to ascertain the density of a pickle by means of the salinometer, a small quantity is taken from the general bulk and the salinometer is floated in it, the degree being read off at once.

The Preserving Process. There are two processes by which meat is preserved by means of salt. One of these is called the wet process and the other the dry process. The latter has been described under Bacon-curing (*see* Vol. I.). The all-important matter in the wet-pickling process is the composition of the pickle.

The following is a recipe which was constructed by the author a good many years ago and which has the advantage of being in use in many countries.

Take 55 lb. of salt,
5 ,, saltpetre,
5 ,, cane sugar,
5 ,, preservative (dry antiseptic or boron preservative);

make these ingredients up to twenty gallons of total bulk and stir all together, after which transfer the whole to a copper or boiling-tank and stir until the whole of the ingredients are dissolved. Boil the mixture as long as a scum rises to the surface, and as it does so it should be skimmed off. The solution should then be allowed to settle, preferably in a separate barrel or tank, and when the floating sediment has settled to the bottom the clear fluid only should be carefully syphoned off into the tanks or vessels in which it has to be used. Under no circumstances should this pickle be used while it is warm, but it should be allowed to cool until it is the temperature of the surrounding atmosphere of the curing-place. At 60° Fahr. it should test 100° on the salinometer. This figure may not be reached owing to the different composition of the ingredients which are met with in various parts, and a fluctuation of 3° or 4° may be disregarded, but anything beyond that should not be allowed, inas-

PICKLING-CELLARS IN THE MEAT EXPORT WORKS, QUEENSLAND much as for the curing of most meats a fairly strong pickle, as is indicated, is necessary. The quantity and the bulk of the pickle given are merely taken as forming a convenient unit, which can easily be multiplied or divided to suit all requirements; the proportions would remain the same.

The Ingredients Used. With regard to the ingredients, it may be said that salt varies considerably, and hence may give rise to apparent discrepancies. Saltpetre should always be of the best quality obtainable, and it does not alter very much. Its use in the curing of meats is to preserve the colour. It has a slightly antiseptic quality also, which at one time was recognised to such an extent that much larger quantities of saltpetre were used in the curing of meats than at the present day. Salt alone has the effect of discolouring the lean of meat, and the saltpetre restores or maintains the red colour which is so much desired. It is possible that this is not due to direct action of the saltpetre, but to its decomposition and the formation of nitrates and nitric oxide in the pickle. Cane sugar should invariably be used, as, according to the experience of many curers, the use of beetroot-sugar sets up fermentation, which rapidly destroys pickling solutions. It is difficult to know why this should be so, but the experience indicated is common amongst practical men. With regard to the use of preservatives, this is a much vexed question. In some countries the use of boron preservative is prohibited. In the United Kingdom it is permitted to the extent of one half of 1 per cent. (·50 per cent.) in butter and other products. That is to say, that a Royal Commission was appointed to investigate the use of preservatives in 1899, and this Commission issued their report in 1901. In this Report they state as follows:

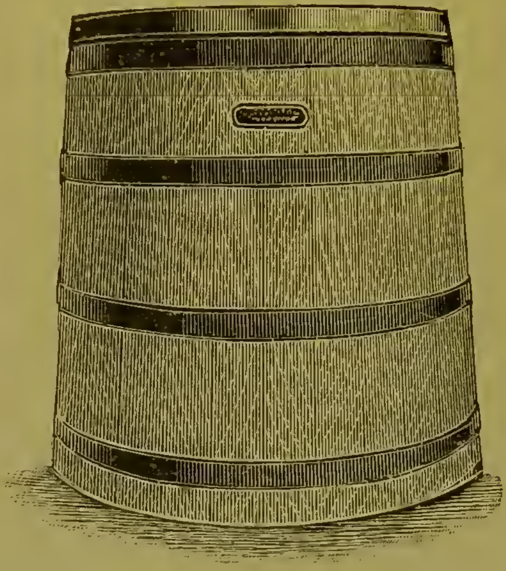
"After very carefully weighing the evidence, we have come to the conclusion that, as regards the trade of fresh and cured meat, fish, butter, margarine and other food substances, in the consumption of which but small quantities of the antiseptic are taken into the system, there exists no sufficient reason for interfering to prevent the use of boron preservatives."

The Committee then proceed to make their recommendation to Parliament in the following words:

"That the only preservative permitted to be used in butter and margarine be boric acid or mixtures of boric acid and borax, to be used in proportions not exceeding 0.5 per cent., expressed as boric acid."

Are Preservatives Injurious? Such a recommendation, while it has not been translated into law, has had all the force of law in the United Kingdom. There have been many attempts to produce evidence which would show that the use of boron preservatives in food is injurious, but the weight of evidence has so far been in favour of the use of such safeguards against decomposition, and this has been emphasised by many cases of ptomaine poisoning which could have been prevented by the judicious use of an inhibitory antiseptic.

Prosecutions, however, have been instigated by medical officers of health and others against the users of preservatives, but in no case have they succeeded in demonstrating injurious effects from them. Such convictions as have been obtained, have been under the section of the Food and Drugs Act (Amendment Act), 1879, where, in the second clause, it is enacted that it is not permissible to sell to the prejudice of the purchasers any article of food which is not of the nature, substance and quality of the article demanded. Under this clause of the Act it has been contended, sometimes with success, that boric acid and other preservatives are adulterants. They, however, would not be regarded as being to the prejudice of the purchaser if notice were previously given at the time of sale that the article being sold contained such preservatives.



Oak Pickling-tub, for Small Quantities of Goods

A General Principle in Pickling. In the construction of the pickle, regard must be had to the use to which it is to be put, and the general principle upon which to proceed is that large portions of meat should be immersed in a pickle of high density, as on the average they are required to be kept for a prolonged period. On the other hand, a lighter pickle may be necessary for goods such as pickled pork and tongues, which may be wanted for immediate use. It is difficult to lay down exact directions in connection with that matter, inasmuch as it must be, to a large extent, regulated by local tradition and practice.

There is a variation of the pickle which is worth noting here. In some parts of the country a certain piquancy is required in meats, and this is obtained by floating on the pickle a bag containing a mixture of juniper berries, coriander seed, pepper-corns and laurel-leaves. A mixture of such ingredients, amounting to about one pound in all, would be sufficient for twenty gallons of pickle, and a corresponding proportion would be required for greater bulk. The piquancy derived from this source is altogether a matter of taste, and the composition of the mixture of the flavouring matters rests also on the same basis. There are parts of the country where, in the curing of meats, a large addition of cane-sugar is made, in order to give a certain sweetness in taste, and frequently maple-sugar is used for this purpose, and this is carried on to such an extent that in place of the five pounds indicated as forming one of the ingredients of the twenty gallons of pickle referred to, the quantity added may be as much as fifteen pounds.

The Process of Pickling. In so far as the process involved in pickling is concerned, it may be described as a kind of osmosis, which really means a transference by diffusion of the meat juices. These diffuse outwards while the solution of salt diffuses inwards, and as a consequence the soluble albuminous juices of the meats are to a large extent lost; there is also a considerable wastage of phosphoric acid. It would appear that during the pickling process the loss of the albuminous compounds and phosphoric acids is gradual up to about the fourteenth day, when the maximum under ordinary curing conditions is reached, and this fact has long been known to curers, who have fixed on fourteen days as the period necessary for the mild curing of bacon and other pork products.

The Art of Pickling. The art of pickling is practised in: (1) the meat-, pork-purveyor's or provision-dealer's shop; (2) on the farm; (3) in the factory. The principles of curing are applicable to all. The methods, however, may vary considerably.

Curing in the Shop. The average shop has generally either a cellar or some back rooms attached, and it is in such places that pickling of meats in the small way is carried on, and such pickling may be applied to various pig and beef products, such as hams and bacon, pigs' feet, pigs' heads, pigs' tongues, rounds of beef, briskets of beef, ox tongues and similar products, and if success is to be attained the surrounding conditions must be of a thoroughly hygienic character. The atmosphere of the room or cellar should be fresh and fairly cool. In many small establishments at the present day there are refrigerating machines which are utilised for maintaining a cool atmosphere in the curing-or pickling-room, and, where such conditions exist, curing may be carried on quite as successfully as in the largest establishments. Ventilation in a room or cellar, where no cooling appliances are available, is a very essential feature, and thorough cleanliness is also indispensable. The curing-vats may consist of oak tubs which are made up to one hundred gallons in capacity, slate tanks, which may be constructed to any size to suit the conditions of the premises; or concrete tanks, which can be built to suit conditions also. In any case, it is desirable that the pickling should be divided up into a number of different receptacles, and all of these should have outlet openings at the bottom, so that they can readily be emptied of the liquid contents when necessary. For this purpose, the bottom of the tanks or vats, should always be raised upon the floor, which should be constructed of impervious material, such as concrete or Caithness flags. It will be necessary to have, besides such pickle-vats; a thermometer for testing the meats and the pickles, a salinometer with testing-glass, a meat-trier for ascertaining the sweetness of meats, and a pickle-pump for forcing pickle into the meats.

How the Process is Carried out. The process of pickling is carried out as follows: If it is desired to cure bacon by the wet process, then the meat is first of all hung in a cool place or chilled to 42° F., so that all the animal heat is entirely dissipated. The meat, sides of bacon, or portions of the sides of bacon, are then pumped by means of a pickle-pump in the fleshy parts. The pickle-pump is necessary where quick curing is carried on. It is simply a force pump, and is used for pumping ordinary pickle through a needle-pointed nozzle which is inserted into the tissues of the meat, and by which a number of small openings are made, so that where the pickle-pump is worked it distributes the pickle immediately wherever it is placed. The forcing in of the pickle by this means, ensures that the risk of taint from rapid decomposition will be reduced to a minimum, owing to the effect of the pickle coming directly into contact with the tissues of the meat and being mingled with the meat-juices. The meat is then thrown into the pickle, which has been made from the recipe already given. If *sides* of bacon are being cured, it will be necessary to keep them for about fourteen days immersed in the pickle. In the making of rolls and Ayrshire bacon this time, however, is much shortened, as, previous to putting the bacon into the pickle it is boned and all the bones taken out, so that it comes more readily in contact with the remaining tissues of the meat. Therefore, where mild curing is carried on, the length of time in the pickle is sometimes reduced to four days. If, on the other hand, the meats are required for keeping a prolonged period, it will be necessary to leave them in the pickle for at least twenty-one days, when the cure will be salty, but will be such as to ensure the meats being kept for a good many months. Winter-cured hams and bacon are generally produced in this way, and, according to the weight, may be kept in pickle for as long a period as twenty-eight days, after which they are removed and hung up to dry, either in the shop or in a room which is free from dampness and where gradual drying may take place. Such a room should be free from sunlight, so as to discourage the attacks of flies upon the meat.

Curing Hams by the Wet Process. In the curing of hams by the wet process much the same method is adopted ; the hams, however, are only pumped in the blood-vein and are then thrown into the pickle, and are weighted down so as to keep them submerged. They are taken out the following day, and the blood-vein is squeezed so as to purge out any blood that may be left, and are then thrown into fresh vats of pickle and are allowed to cure, either as mild-cured hams or as hams for keeping purposes. Winter-cured hams are kept in pickle for a long time, and this must be regulated by the weight of the hams themselves. In Yorkshire it is customary to cure hams weighing as much as 40 lb., and when these are cured by means of pickle they are kept for at least forty-two days in the pickling solution, after which they are hung up in a dry, dark place and are allowed to develop a blue mould, which is looked upon as a necessary " bloom " in such products.

In the curing of rounds of beef the same cure is desired, and when the rounds of beef are prepared they are pumped by means of the pickle-pump and are thrown into the pickle, being kept there for a period of time which varies according to the taste of the corned beef required.

In the curing of tongues, pigs' heads, pigs' feet and houghs, much is left to the judgment and requirements of local trade, but it may be generally laid down that such goods are wanted in a mild-cured condition, and this can be obtained by keeping them in pickle for from four to five days. Briskets of beef to be used for making braised beef are sufficiently cured when kept in pickle for five days. Ox-tongues also, when they have been properly veined and pickle injected up the veins, are sufficiently cured in four or five days.

Curing on the Farm. The general principles which have been applied to the curing of meats in shops are also those which can be conveniently adopted on the farm. Generally there are cool rooms or spaces in a farm steading which can be utilised for the curing of meats, and, as a matter of fact, in Cumberland, Westmorland, Yorkshire and Ayrshire, such places are frequently provided as an essential part of the farm buildings. All the appliances which are necessary for curing in the shop are equally necessary for curing on the farm, and the processes are practically identical throughout.

Curing in the Factory. In curing in the factory a different set of conditions is set up. The modern factory is equipped with refrigerating machinery, and the curing- and pickling-departments are generally on an extensive scale. The advantage of using refrigerating machinery in the curing of meats is very great, as it enables the curers to chill their meat previous to its being placed in the pickle and so prevent any risk of taint, which may be disastrous on a large scale. Curing-vats are generally constructed, on a large scale, of concrete, and are divided up just as they are in the small way, the difference being that the dimensions of the vats in the factory are greater and in proportion to the business that is done. The constitution of the pickle and the operations are the same throughout, and the products are identical but are produced in greater quantities.

The Drying of Meats. The drying of pickled cured meats is a very important part of the process, and this is best conducted on the large scale in a dark-room, or a room which is lighted only with crimson-tinted glass, as this prevents the propagation of flies. The temperature of a drying-room should be about 80° to 90° Fahr., and the drying process generally occupies about three days.

The Testing of Meats. It is necessary to ascertain whether meats are soundly cured or not, and for this purpose the trier is used. It is simply a flat steel, narrow blade which is pressed into the muscles of the meat and withdrawn; the condition of the meat may then be determined by the smell of the trier, and obviously this requires some little practice. In any case, all meats before being sent out should be tried by the trier, and, when it has been inserted into different spots, care should be taken to close up the opening that has been made, with the finger. The trier should always be kept perfectly clean.

The Smoking of Meats. When smoked meats are required, they are prepared by taking the dried meats and hanging them in a smoke-stove, which may be constructed either of brick or may be of a portable character. On the large scale, smoke-stoves are built usually in three or four storeys, so that smoked meats may be hung in them in large quantities. The smoking in every case is identical, the effect being produced by a hardwood sawdust from oak, beech or ash. The sawdust is lighted and allowed to smoulder, so that the smoke rises through the meats and the tarry matter is deposited over the surfaces. Care should be taken that the smouldering sawdust is not too near the meats, or there is danger of the lower meats being cooked. In large smoke-stoves an open space of 10 ft. high is generally provided between the sawdust and lower meats, and this ensures that the smoke will be equally distributed. The temperature of the smoke-stove should be from 85° to 90° F., and the process occupies generally about three days. In some parts of England, however, where dark smoked goods are wanted, the smoking may occupy a week or even more, and the loss in weight, due to the evaporation of moisture from the meat, is correspondingly great. Hence, heavily smoked meats are always worth more in the market than those which are merely dried or lightly smoked.

The smoking of meats has a preservative effect, which is due to the diffusion of creosote, pyroligneous acid, and other empyreumatic oils. It has also been shown that formic acid enters into the smoke and is deposited on the meats. The whole process, therefore, is one of preservation, which is carried on at the expense of the weight of the meat.

Navy Pork. Wet pickled meat, which is largely manufactured in Ireland for the British Navy, is what is classified as navy pork. Every year the Admiralty ask for tenders for the supply of salt pork for the navy, and lay down certain conditions which must be observed by curers. These may be summarised as follows:

Whole pigs must be used, and it is one of the Admiralty conditions that each cask must contain a proportion of the different parts of the pig —hams, backs, bellies and coarse meat (that is, necks, legs and forelegs). The usual weight of the pig is from 1 cwt. 3 qrs. to 4 cwts.

Pork is made from hog-pigs, and neither sows nor boars are allowed to be used. Also, it is stipulated that the meat must not be too fat.

Pigs for navy pork must be chilled in the usual way, then cut as follows: The back is cut down, the bones being sawn through; the two sides are cut again from the fore-end to the ham in equal parts, thus making four long strips of the carcase. The back pieces are chopped with a chopper into pieces weighing as nearly as possible 4 lb. each (this is termed "messing"). The belly-pieces are salted whole, and are cut into 4-lb. pieces after being taken out of pickle.

After pork is "messed," it is rubbed with salt and put down into large square tanks, holding possibly five tons each of meat, or any other convenient size. It is packed firmly together in these tanks, then sprinkled lightly over with saltpetre, and next sprinkled heavily with salt. The whole is allowed to lie for twenty days, after which it is "drawn" or taken out, and the largest pieces are cut into 4-lb. sizes. This cutting must be accurately done, as any serious discrepancy in weights will render the whole consignment liable to rejection by the Admiralty officials.

The pieces are weighed in lots of 200 lb. each, care being taken to have the various sections of meat equally proportioned.

The packages are then made up in weights of 100-lb., 200-lb. or 300-lb.

barrels, according to the requirements of the contract. St. Jubes salt is added to the casks, being sprinkled over the meat as it is packed, and after the casks are headed up they are filled with pickle by the bung-hole.

The casks have all to be of standard sizes specified by the Admiralty. The following is the form of tender for navy pork :

"SALT PORK

" *To the* Directors of Navy Contracts,
" Admiralty, London, S.W. v. 19.

" We, of
in the of ,
hereby offer, in consideration of payment being made to us at the rates quoted in the following Schedule, to supply and deliver at the Royal Victoria Yard, Deptford, all or any of the quantities of salt pork against which we have inserted prices, subject to the conditions stated on the following pages.

" One-third of the casks of each description to be delivered by the * one-third by the * , and the contract to be completed by the 20th March next.

" (*See* notice below.)

" *Signature,*

" *Witness,*

Postal Address,

NOTICE TO PERSONS TENDERING

" (1) Tenders need not be for the whole of the quantities required, but no tender will be entertained for a less quantity than 100 casks of either description. Early delivery is desired.

" (2) Tenders for salt pork of the cure of the United States of America will not be considered.

" (3) Net prices should be given, all trade discounts being allowed in the quotations.

" (4) Tenders will be received until noon on day of , 1 . They should be addressed to 'The Director of Navy Contracts, Admiralty, London, S.W.,' and marked in the left-hand corner 'Tender for salt pork.'

" (5) Their lordships do not bind themselves to accept the lowest or any tender, and they reserve to themselves the power of accepting any part of a tender.

" Attention is particularly directed to the absolute necessity for delivery by the dates named."

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* To be filled up by firm tendering.

CONDITIONS OF CONTRACT *

(1) **Quality.** The pork is to be well-fed, prime, good, sound, sweet, fat, entirely free from measles and rust, properly cut without pockets from the carcases of hogs only, weighing not less than 168 lb. each, and well messed in pieces averaging, when weighed after six hours' drainage, at least 4 lb. each as regularly as the bones will admit of, one with another, and freshly cured and packed. The whole of each hog cured, including the hams, is to be put in the casks, with the exception of the head, cheeks feet, skirt and offal. In curing the pork a full and sufficient quantity of saltpetre is to be used. The examining officers shall be at liberty to apply to the pork the test of boiling, or any other test they may consider necessary.

(2) **Packages and Cure.** The pork is to be delivered in casks of 300 lb., 200 lb. or 100 lb. each, as agreed. Each 300-lb. cask is to contain seventy-five pieces of pork, weighing at least 300 lb., each 200-lb. cask fifty pieces weighing at least 200 lb., and each 100-lb. cask twenty-five pieces weighing at least 100 lb., the weight of the meat being ascertained after six hours drainage. The casks are to have at each head and between the several layers of meat a layer of clean genuine bay-salt, of good quality, consisting of well-formed colourless crystals, and to be full of pickle. Each 300-lb. cask is to contain on delivery not less than 60 lb. of salt; each 200-lb. cask not less than 45 lb.; and each 100-lb. cask not less than 30 lb. Each cask is to have branded upon the head the name of the curers, together with the place of cure and the number of pieces it contains.

(3) **Casks.** The casks are to be strong, stout, substantial, and of sufficient capacity, made from Baltic staves free from sap and worm-holes, or from staves of equal goodness. Each cask is to be bound with eight good and substantial iron hoops placed as follows, viz., two on each chine, one on each bilge and one on each quarter. The heads of the 300-lb. casks are to be not less than $\frac{7}{8}$ in. thick, and the staves not less than $\frac{3}{4}$ in. thick in any part; the heads of the 200-lb. casks are to be not less than $\frac{3}{4}$ in. thick, and the staves not less than $\frac{5}{8}$ in. thick in any part; the heads of the 100-lb. casks are to be not less than $\frac{3}{4}$ in. thick, and the staves not less than $\frac{5}{8}$ in. thick in any part. The iron hoops on the 300-lb. casks are to be $1\frac{1}{4}$ in. wide, and of No. 13 wire gauge; those on the 200-lb. casks $1\frac{1}{4}$ in. wide, and of No. 14 wire gauge; and those on the 100-lb. casks $1\frac{1}{8}$ in. wide, and of No. 15 wire gauge. Galvanised iron hoops may be used provided they are of the gauges herein specified *before* galvanising, and that they stand the ordinary driving to which they will be subjected.

(4) **Delivery.** (*a*) *By Van or Cart.* Pork delivered by van or cart is to be deposited at the door of any storehouse, or on any quay, or alongside any ship in the yard, as may be required by the officers. Assistance in unloading will be given by yard labour.

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* For the purposes of this contract the word "hog" is to mean a male barrow-pig and a female pig that has not been used for breeding purposes.

(*b*) *By Rail into the Yard.* Pork delivered by rail into the yard will be unloaded by yard labour.

(*c*) *By Ship or Barge.* Pork delivered by ship or barge is to be slung by the ship or barge if a yard-crane be available, and will be hoisted out by yard labour. No charge will be made for the yard-cranes in performing these services, but all risks of damage to craft or goods during process of discharge are to be borne by contractors, other than damage due to defective dockyard cranes, chains or other machinery.

If no crane be available the pork is to be delivered by the ship or barge on the quay.

(5) **Rejection and Removal of Rejected Pork.** Should any portion of any delivery under the contract be found, on inspection by the examining officers, not in accordance with the conditions of the contract as regards quality, brand, casks or cure, the officers are to be at liberty to reject the whole delivery. All pork rejected is to be removed by and at the expense of the contractors immediately after notice shall have been given to them of the rejection. If not taken away within fourteen days, the pork will be returned through the same channel by which it was delivered, and all expenses incurred thereby will be charged against the contractors.

(6) **Warranty.** The contractors guarantee that all pork to be delivered under the contract shall keep perfectly sound, and fit for use, for two years from the date of delivery into store. Any cask found on survey, held within that period, to contain pork inferior in quality to that stipulated for, or to contain any pieces which are specially excluded under clause 1, may be condemned and sold if practicable, or destroyed if necessary. The amount paid for pork thus condemned, with 5 per cent. added, together with the amount of freight paid on the same, less the net amount realised if sold, shall be a debt due to his Majesty from the contractors and recoverable as such.

(7) **Arbitration.** In the event of a rejection of pork by the officers whereby the contractors may consider themselves aggrieved, a re-survey of the pork by two independent persons—to be agreed upon by the parties to the contract—or their umpire, will be allowed if, before the pork has been removed, the contractors shall, in writing, apply to the financial secretary of the Admiralty for a re-survey, and shall sign the submission to arbitration required by the Admiralty in such cases (a copy of which will, if desired, be furnished to the contractors before tendering), and pending such arbitration the pork is not to be removed.

(8) **Transfer of Contract.** This contract, or any part, share or interest in it, is not to be transferred or assigned by the contractors to any person or persons whomsoever, without the written consent of the Admiralty.

(9) **Wages.** The wages paid in the execution of this contract shall be those generally accepted as current in each trade for competent workmen in the district where the work is carried out.

(10) **Power to Terminate.** The Lords Commissioners of the Admiralty may at any time terminate the contract if the contractors shall be adjudged bankrupt, or if under any present or future Bankruptcy Act any

receiving order or order for the administration of their estate shall be made against them, or if they shall enter into, make, or execute any deed of arrangement as defined by the Deeds of Arrangement Act, 1887, or other composition or arrangement with, or assignment for the benefit of, their creditors, or purport to do so; or if (in Scotland) they become insolvent or notour bankrupt, or application be made under any present or future Bankruptcy Act for sequestration of their estate, or application be made by them or any of their creditors for *cessio bonorum* against them, or a trust deed be granted by them for behoof of creditors.

(11) **Payment for Supplies.** With every delivery of pork under this agreement, invoices,* in duplicate, are to be sent to the consignee by the contractors. The duplicate will be returned by the consignee, with the quantities received noted thereon. The contractors are then to send their claim † for payment to the Accountant-General of the Navy, Admiralty, Spring Gardens, London, S.W. After the necessary examination in office of the claim thus sent, an order for payment of the amount due will be forwarded by him to the contractors.

SCHEDULE

Number offered.	Place of Cure.	Brand of Meat.	Name of Person by whom Cured.	Net Price including Delivery. £ s. d.
Casks of 300 lb. each.				Per Cask of 300 lb.
Casks of 200 lb. each.				Per Cask of 200 lb.
Casks of 100 lb. each.				Per Cask of 100 lb.

NOTE. *See* clause 1 of "Notice to persons tendering."

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* Forms may be obtained on application to the Accountant-General of the Navy, Admiralty, Spring Gardens, London, S.W.

† *Instructions for Contractors.*—Consignment.—The names of the contractors on the packages and the posting of invoices immediately after the pork has been forwarded will much facilitate receipt.

American Pickled Meats. There is a great variety of pickled meats made in the United States, but these do not differ so much in the process of curing as in the sections under which they are classified. Sweet pickles are largely in use, and the sweetening property is due either to sugar, glycerine or molasses. Formulæ, however, for these pickles seem to vary very much in different districts, and there does not appear to be any recognised formula for pickle which would apply generally to the American packing industry.

END OF VOLUME II.

25 JUL. 1929